POWER PLANT ENGINEERING

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St. Paul Public Library Heating and Ventilating

A MODERN, SCIENTIFICALLY DESIGNED PLANT, EMBODYING FANS WHICH MAKE SIX CHANGES OF AIR PER HOUR. BY C. S. TOMPKINS

THE MOVEMENT for the erection of a new library building in St. Paul began in 1912, at which time James J. Hill offered to give a sum of $700,000 for the building and endowment of a reference library and make it a part of the public library foundation, if the city would proceed with the erection of a building for the library. Funds for the purchase of the site were immediately raised by popular subscription and bonds voted for the erection of the building. In 1917, the building was completed at a total cost of more than a million dollars.

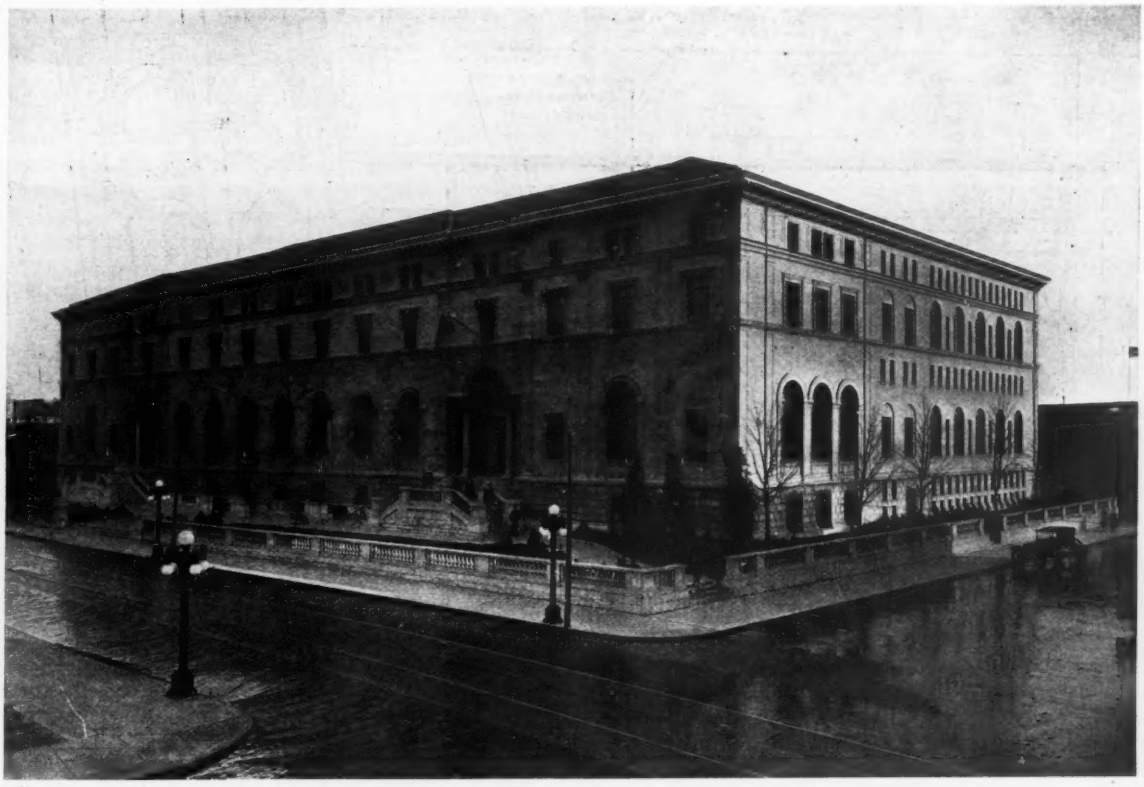


FIG. 1. EXTERIOR OF THE ST. PAUL PUBLIC LIBRARY

Figure 1 shows the exterior of the Public Library building, which occupies the square, bounded by 3rd, 4th, Market and Washington Sts., overlooking the Mississippi River to the south and facing Rice Park and the Post Office on the north. The general spirit of its architecture is that of the Italian Renaissance. The exterior is of selected pink Tennessee marble, while the principal rooms of the interior are finished in vesta gray Mankato stone. The woodwork throughout is of maple impregnated with a soft gray stain, recalling the color of the stonework. The floors of the three principal rooms are covered with cork tiles made by compressing about 14 cu. in. of cork into 1 cu. in. and filling with linseed oil, thus giving the tiles the wearing quality of marble and at the same time leaving them waterproof. The elevator doors are of bronze and are richly decorated

in Renaissance designs containing monograms of the library.

At the right of the entrance is the Delivery Room, at the left, the Periodical Room. On the second floor, at the right, is the Greenleaf Clark Reference Room, named in memory of Judge Greenleaf Clark, one of the benefactors of the library. At the left of the elevator are the special reference rooms devoted to civics and related social sciences, industrial arts, and fine arts. On the third floor, at the right is the Accessions Room in which books are ordered, classified and catalogued, while at the left are the Librarian's Office, the Staff Rooms, and at the end of the corridor, the Exhibition Room. On the ground floor, at the right of the elevator, is the Newspaper Room; at the left, and at the end of the corridor, the Children's Room. Adjoining the latter are the Teachers' and Parents' Room and the office of the school department, and on the north side of the corridor, the Library Auditorium.

The stack room, which provides accommodations for about 500,000 volumes, occupies the west wing of the building and extends from the ground floor to the roof.

Ventilating System

The ventilating system of the building is divided into three units, as follows:

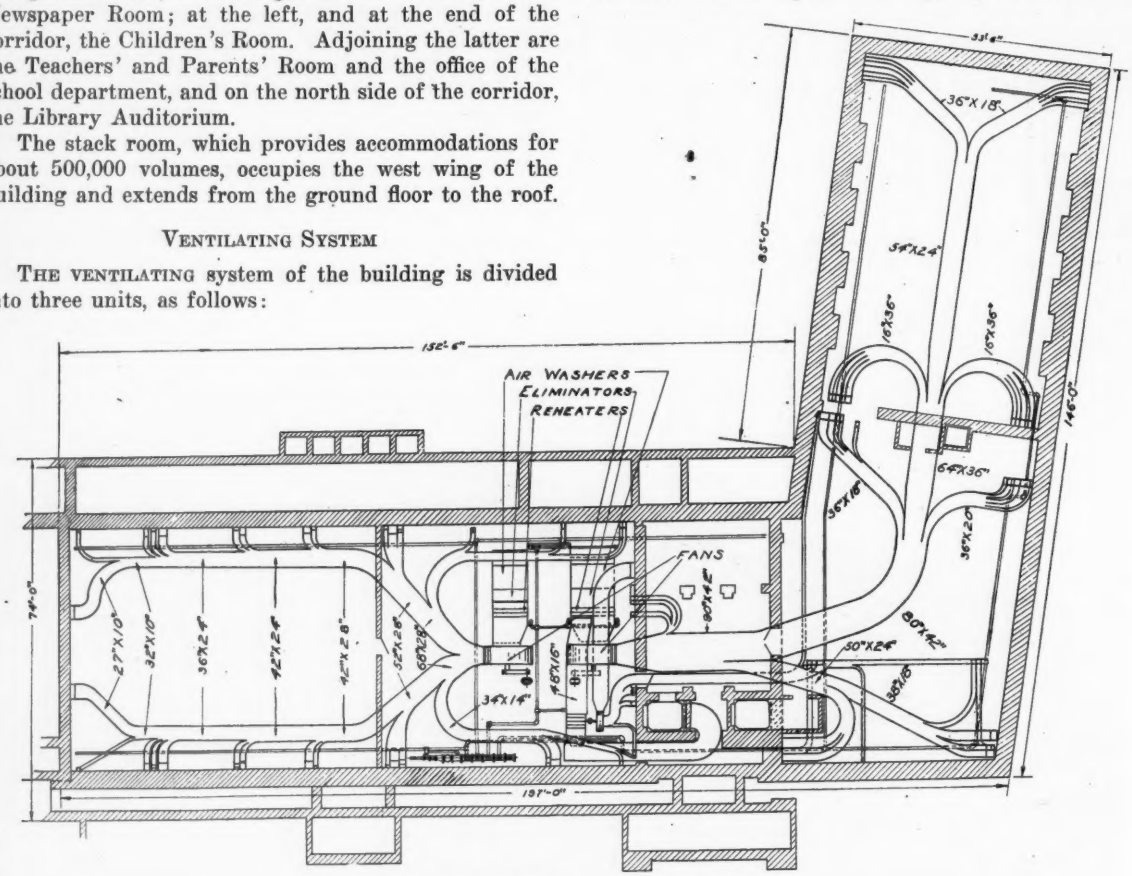


FIG. 2. PLAN OF THE AIR DUCTS IN BASEMENT

1. General ventilation system is both plenum and exhaust and will serve practically all the rooms in the building excepting toilets, lobbies, stair halls, vestibules, court rooms, conversation alcove, etc. The plenum fans together with the heaters, washers, etc., are located in the main fan room in the sub-basement. The exhaust fans (disk type) are located in the two exhaust fan rooms in attic space.

2. Toilet ventilation system is exhaust only with fan in main sub-basement fan room and serves all toilets in the building and also janitor's room on the ground floor.

3. Main lobby ventilation and heating system is hot blast with fan and reheaters located in main fan room in sub-basement. See plans for the details and schemes of distribution for all of the above-mentioned systems.

The outside screen for fresh air intake opening and all foul air outlets are indicated on plans, and also the cutoff doors for the main intake opening (size of opening 8 by 8 ft.). These doors are operated by hand, and are of the roller type, running guides at top and bottom and of size and tightness of fit such that they completely cut off all cold air from outside. The doors are made of 1¼-in. matched wood.

The ventilating machinery in the sub-basement provides for a change of air every 6 min. and not only purifies the air, but, in the summer months, cools it. In Fig. 3 is shown one of the two large air conditioning machines for furnishing air to all parts of the building. The motors are 15 hp. and the capacity of the fan shown is 32,000 cu. ft. per min. Its mate has a capacity of 42,000 cu. ft. A separate unit for the main lobby has a capacity of 13,000 cu. ft. Noiseless V belts are used to connect the motors to the fans. The humidity and temperature of the air passing through the system is thermostatically controlled.

The air washers consist of horizontal air chutes or passages opening directly into spray chambers, arranged so that the air will pass through water sprays and spray chambers horizontally without making any swerves or turns, the water striking the air transversely. The spray nozzles are of the latest and highest grade type, of brass with removable caps, size of openings 3/16 in. and are set in such relation to each other that the velocity of air through the water sprays is even and uniform. The

number of spray nozzles per 1000 cu. ft. of air is about two and a half. The flooding nozzles are set directly over eliminators to keep a constant supply of water flowing down to wash the surface of the eliminators. Flooding nozzles number about one to every 3 in. of washer width.

The apparatus contains a storage and settling tank, a spray chamber, or wash box, a properly designed eliminator, a suction strainer, which provides about 12 sq. in.

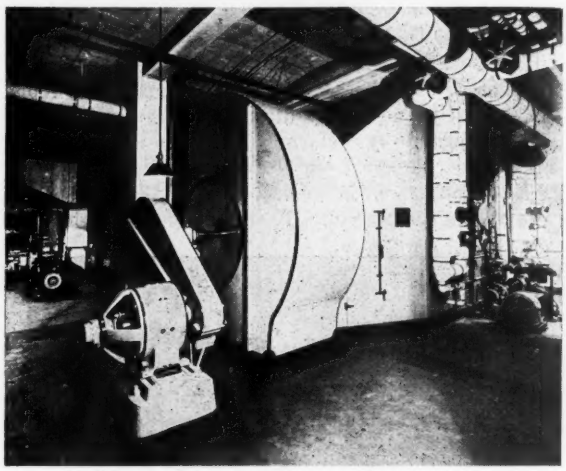


FIG. 3. ONE OF THE LARGE FANS IN THE BASEMENT

of screen for each nozzle used, discharge and supply pipes, a flush out pipe with valves to sewer, supply pipe with automatic supply and cutoff arranged to keep an even level of water in the tank, and nozzle flushing equipment with automatic control.

The casings are provided with solid plate glass inspection windows, two to each washer, made absolutely water tight by means of rubber gaskets. The settling and storage tank is 16 in. in depth and of the same length and width as the spray chamber; tank is riveted and soldered throughout and rigidly braced along the outside, both horizontally and vertically, with 1¼ by 1¼-in. brass angles.

On a 6-in. high finished concrete foundation is a direct connected, centrifugal, double action, horizontally split shell pump for circulating the spray water. Both pump and motor are mounted on a single cast-iron subbase. Pump is of improved type with enclosed impellers, and of proper capacity for the service and designed to operate against a head of not less than 35 ft.

Motor drive consists of 220-v., direct-current machine of same make as furnished for drives of fans. All piping connections between washers and pump are of extra heavy galvanized pipe; flanges are provided on both sides of washer casing, fastened with rubber gaskets and bolts, for the suction and discharge connections, overflow and water supply connections. There is provided in connection with each washer an automatic absolute humidity control for controlling the saturated temperature or dew point leaving the washers. This consists of an all metal graduated action thermostat placed in the air chamber leaving the washer, and includes the necessary diaphragm valve of ejector water heater so as to vary the temperature of the spray water as required by varying the steam supply to the ejector water heater, which operates noiselessly with from 3 to 5 lb. steam pressure. The humidity controlling system is complete

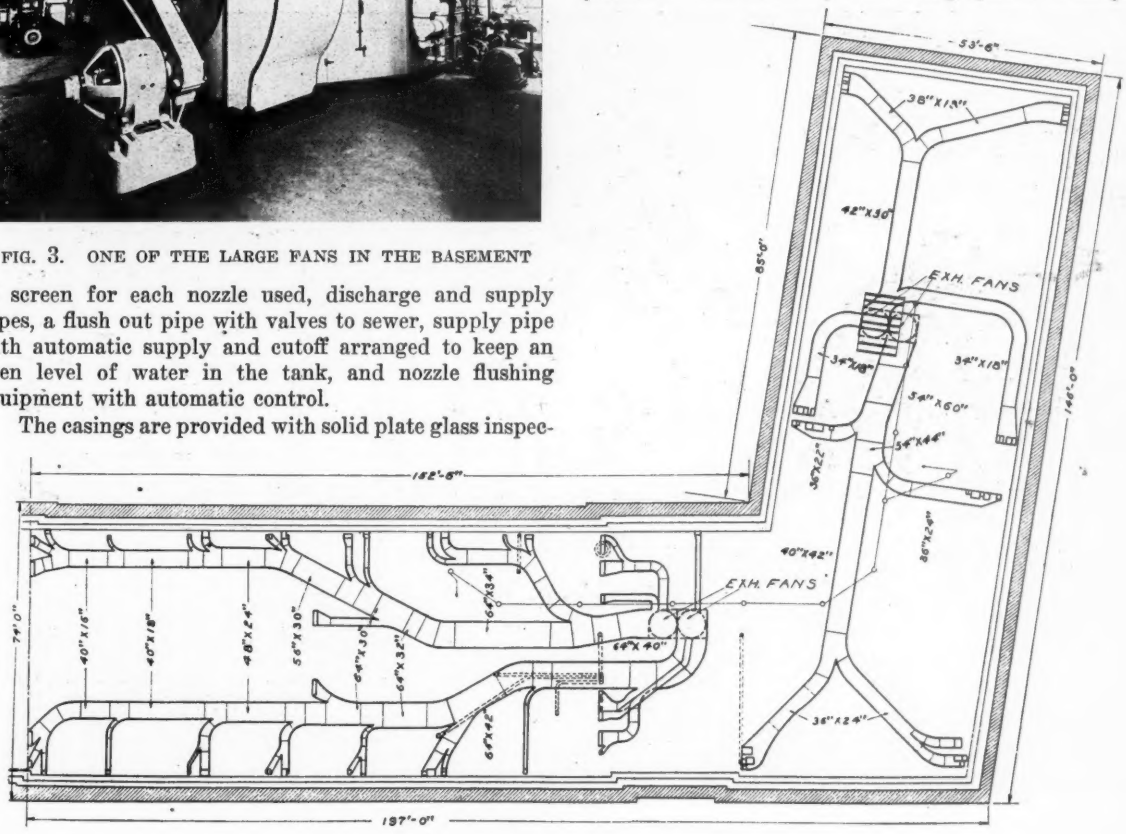


FIG. 4. PLAN OF AIR DUCTS IN ATTIC

with all the necessary diaphragm valves, together with duct thermostats, compressor, filter, strainers, air piping, etc., as required for correct and satisfactory operation, including the necessary pressure reducing valve, with by-pass, and all connections between high pressure service and ejector water heater. An automatic safeguard is provided to prevent the introduction of steam to air in case of failure of spray water temperature or air pressure.

The washers are so designed, constructed and installed that they will remove at least 98 per cent of the solid matter carried by the entering air, that the elimina-

tion of water is entire and complete, that the static resistance of the washer shall not exceed ¼-in. water gage at 500 ft. velocity, that the humidity controlling system will maintain the temperature leaving the washer within one degree of that for which the thermostat is set whenever the heating of spray water is necessary, that the air entering the washer at 35 deg. F. the spray water heater is of sufficient capacity to raise the temperature of this air to 40 deg. saturated, leaving the washer, thus maintaining the grains of moisture constant, that the cooling efficiency of the washer is not less than 60 per cent of the entering differences between the wet and dry bulb temperatures of air.

The humidity of the air in the building during the last two winters was maintained at from 32 per cent to 44 per cent, which is about right for a building of this kind.

to the concrete floor slab above, but with a 2-in. layer of cork board between timber frame and concrete ceiling.

All disk fans are of the standard propeller blade type with vertical shafts and direct connected motors.

Temperature Control

A complete system of temperature control for all ventilating apparatus and all direct radiation of building except rooms designated as lobbies, coat rooms, vestibules, stair halls, toilet rooms, and conversation alcove.

The thermostats are ornamental in finish and design to harmonize with the hardware trimmings of the room. Each is neatly and firmly attached to the wall and is readily adjusted by detachable key to any ordinary temperature (namely from 60 to 80 deg.).

The temperature control valves are of the kind known as "diaphragm" valves. They are offset angle type

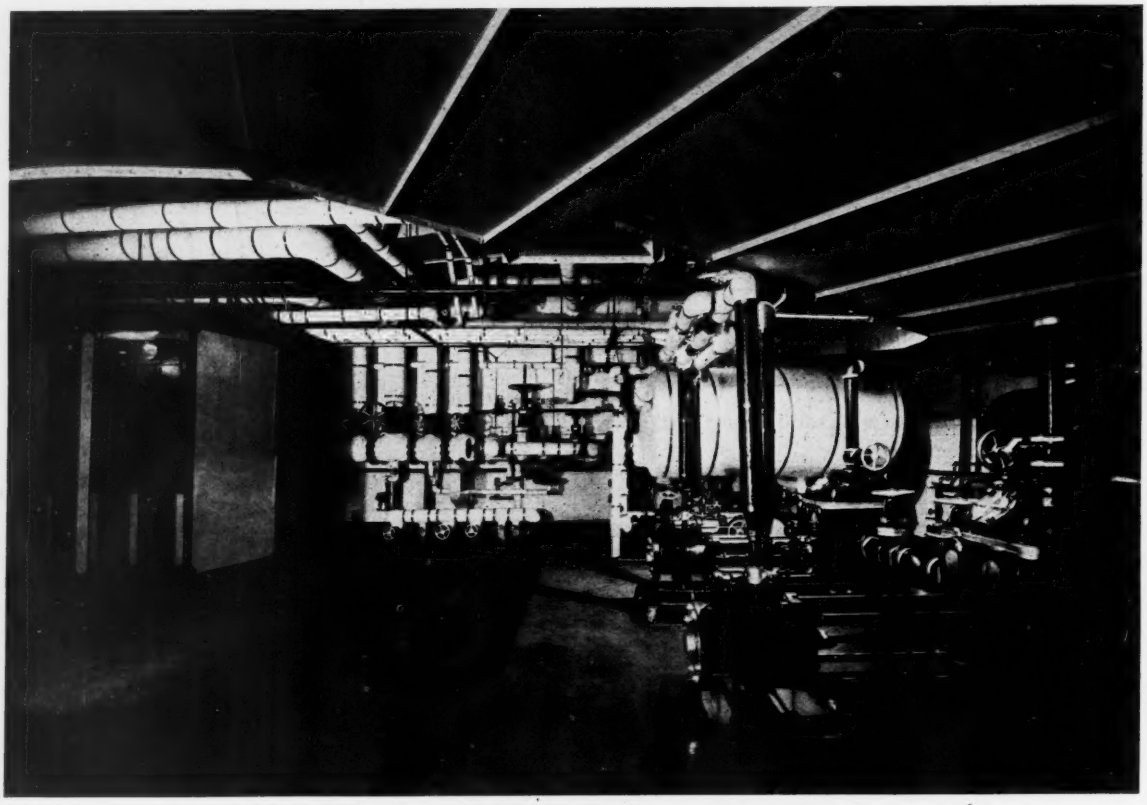


FIG. 5. HEATING PLANT EQUIPMENT IN BASEMENT

Four exhaust fans, of the disk type, are located in the attic and the balance draft system of ventilation is used. Therefore, all windows are fastened so that nobody can interfere with the system of ventilation.

All bearings on fans are of the ring type, self-alining and self-oiling, and are provided with glass oil gages, and brass drawoff cocks so placed that they may be seen outside of the housing. Fan wheels are constructed in the most rigid manner and thoroughly balanced. The fans are so designed, constructed and mounted that they will operate noiselessly and without vibration. Fans and motors are mounted on heavy timber frames countersunk in concrete floor slabs.

The fans supported from the ceiling are firmly bolted to timber frame, in turn bolted by through-going bolts

or straightway type, according to the method used in connection. The air piping system is known as the "loop" system. The mains on each floor supply ¼-in. pipe branches, which in turn are reduced through ¼ by ⅛-in. reducing ells, and rise with ⅛-in. stubs to points 4 in. high behind radiation, at which points they ell out through the baseboard.

Mains on several floors are connected with the compression tank in the fan room in the sub-basement, by means of three 1-in. vertical risers as indicated on plans. All of the air piping is of galvanized iron pipe with galvanized iron recessed type fittings. All piping is placed in position in a neat and substantial manner, and is concealed except in the sub-basement. The air compressor is of ample size and capacity to supply the necessary

amount of compressed air for operating the temperature control of the building. The compressor is steam driven, its size being 4 by 3⅝ by 6 in. Air pressure is maintained at 12 lb. The compressed air tank is of the size corresponding to the specified capacity of the compressor, and is equipped with hangers and supports, drips, gage and all necessary fittings and connections. The tank is galvanized iron and is of such design as to be suitable for normal working pressure of 100 lb. per sq. in. The compressor and tank are located in the fan room in the sub-basement.

The temperature control system is extended to the ventilating apparatus as follows: All sections of the heaters, except the first section in the tempering heaters, are controlled by diaphragm valves. The diaphragm valves of the tempering coils are controlled by duct thermostats placed on the fresh air intake side of the tempering heaters, and are set to keep entering air from falling

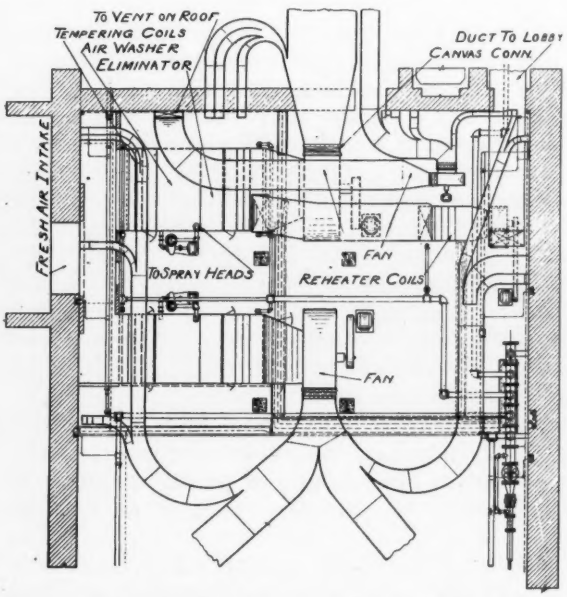


FIG. 6. ARRANGEMENT OF AIR CLEANING AND HEATING EQUIPMENT

below 35 deg. F. Diaphragm valves on the reheater coils for fan units Nos. 1 and 2 are controlled by duct thermostats located in the duct system near the fan. These valves are set to keep the air at approximately 68 deg. F. in the duct systems. Diaphragm valves for mass heater for lobby fan, unit No. 3, are controlled by graduated thermostats located in the main lobby on the first floor, and maintain the lobby temperature at 70 deg. F.

During the winter, the temperature of the rooms is from 68 to 70 deg. F. and on the hottest days of the summer, the temperature in the building has been from 9 to 18 deg. cooler than the outside temperature, according to the temperature of the cooling water available. The machines were installed with a guarantee of 60 per cent cooling effect; but that has been exceeded, due to the low temperature of the cooling water.

Radiator Valves and Return Valves

All radiators not supplied with temperature control are equipped with packless radiator valves, which are rough bodied and are equipped with unions and wood hand wheels. Radiator valve sizes conform to the standard for two-pipe vacuum work. The return connections of all radiators are equipped with return valves of the vacuum equipment..

Figure 5 shows the arrangement of the heating plant. The direct and indirect heating is thermostatically controlled. At the right is shown a duplicate set of vacuum pumps, one pump being used at a time. The large round tank in the right-hand corner is a hot water heater of 750 gal. capacity. The water is heated by the condensation of the heating plant passing through it on its way to the vacuum pump. In the summer months when steam is not used this heater is cut out and a 90 gal. gas heater (not shown) is put in service.

In the center of Fig. 5 is the steam pipe arrangement, all header and return valves of the heating plant are shown here. The 5-in. steam line enters the engine room through the wall behind the hot water heater and runs along the wall to the low pressure distribution header. The main steam valve is the first valve to the left of the hot water heater; next to this valve can be seen the main reducing valve. Along the wall, a little above the low pressure header can be seen a 1¼-in. auxiliary line with a reducing valve, this small line takes

FIG. 7. SHOWING DIRT REMOVED BY THE WASHERS

care of the heating plant in mild weather and the large valve is used in cold weather. By using this arrangement the consumption of steam is kept at a minimum. On the extreme left of Fig. 5 is the control board by which all motors of the ventilating system are controlled. A push button control has been installed for controlling the exhaust motors in the attic of the building. Overhead is seen a part of one of the mammoth air ducts.

All of the mechanical equipment of the building is controlled from the engine room and complete records of every day's work are kept.

In Fig. 7 an excellent example of the efficiency of the air washers is shown. The jar in the middle of the group shows the clear water as it goes into the washer; the jar to the right shows the condition of the water after washing the air. This sample was taken from the washer. In the jar to the left is shown fine dry dirt that was taken from the air as it passed through the water on its way into the building, and was left in the washer.

The engine room, as well as the rest of the building, is open to the public and hundreds of people have visited the plant.

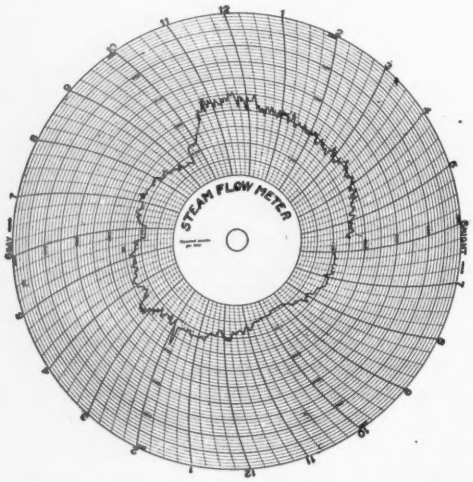
FUEL CONSERVATION LETTERS

By Joseph Harrington, Formerly Administrative Engineer for the State of Illinois

Boiler Room Instruments. Letter No. 22

As A conclusion to this series of letters, a discussion of what constitutes essential boiler room instruments seems fitting.

What is the ultimate object to be accomplished by the installation of boiler room instruments? It is, in all cases, for the purpose of giving information which will lead to a reduction in the amount of coal required for producing a given amount of steam; or conversely, to enable the boiler to evaporate more water with a given amount of coal. However, the coal water ratio is the one thing, and the only thing affected. Therefore, the whole matter becomes ineffective unless we know what is the effect on this ratio. To determine this we must know both the weight of coal and the weight of water. No matter how large or small is the plant, if only one thing could be determined, I would say that this is it. I have known of many instances where simply weighing or measuring the coal and establishing an interest on the part of the fireman in reducing the amount of coal burned, resulted in heavy savings. In this case, the daily total of steam consumption was practically constant so that the problem simplified itself to a mere weighing of the coal. In such cases, little changes in the furnace brickwork, method of firing, frequency of soot-blowing, etc., had a reflection in the amount of coal used; so that as these economies were put into effect, the fireman saw the direct result in his coal weights. After all, this is what we want; and any means for securing this desirable result is acceptable.



My answer, therefore, to the question of the most essential boiler room fact, is that the daily amount of coal must be known, and if in any way possible, the amount of coal to each individual boiler. Next to this, and almost as important, is the amount of steam produced, if possible, by each. This may be accomplished by steam flow meters, water flow meters, Venturi tubes, V-notch meters, or water weighers.

Not all boiler rooms can be equipped with a recording instrument on each boiler, but every boiler room can be equipped with a gas collector on each boiler and a hand analyzer for the plant.

The problem is not merely to obtain maximum CO_2, but to obtain that percentage which gives us the highest evaporative ratio. The highest percentage of CO_2 does not by any means correspond with the highest ratio. As the combustion chamber is enlarged, as uniformity of furnace conditions increases, a higher CO_2 can be carried, and up to a certain point increased efficiency; but in restricted furnaces the point of maximum efficiency corresponds with the point of maximum completeness of combustion, and not necessarily with maximum production of CO_2.

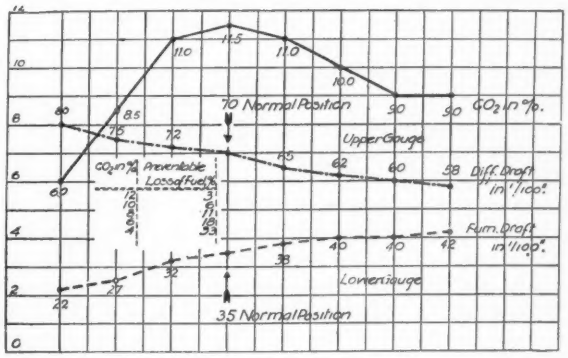
The gas analysis must, therefore, be studied with direct reference to the evaporative ratio, and when the point of best efficiency is determined for the specific boiler under consideration, this becomes thereafter the standard for that unit.

Gas analysis, indicating as it does the amount of air taken into the furnace, measures the loss due to excess air. This is a furnace loss, and, together with the ash pit loss, becomes a measure of furnace efficiency. Both of these are largely controllable losses, so that a close check on them is necessary.

After the furnace losses are thus gaged, the next most important indication is the temperature of the waste gases. The flue temperature thermometer, indicating this directly, then becomes the next instrument I should select. The loss of heat up the chimney is one of the largest losses in the boiler room, and it also is largely under the control of the designer and operator. Flue temperature is affected by the amount of excess air taken into the furnace, so that this indication is tied in with the CO_2. It is also directly affected by the condition of the heating surface, both inside and out, the tightness of the baffles, and the extent to which the baffling is carried. It is also directly affected by the rate of steaming, so that we have in this single indication the composite result of quite a number of conditions which are all more or less controllable.

Now, if nothing further can be done with our boiler room, a very fair degree of operating efficiency could be maintained with those indications which we have already decided upon, viz., coal weights, steam weights, gas analysis, and flue temperatures. These I would term the four primary instruments absolutely essential to best operation.

Suppose now, however, the small plant owner does not feel equal to the cost of the above instruments and considers that he could not use them intelligently if he did have them, what can be substituted therefor? My answer is a draft gage connected to the boiler furnace and another one to the boiler uptake, just inside of the boiler damper. These can either be read directly or can be cross connected so as to show the drop through the boiler rather than the direct reading at the damper.



It is a well-known fact that furnace draft is really only a measure of the resistance of the fuel bed to the passage of air, and that every change in the condition of the fuel bed produces a corresponding variation in the resistance as indicated by the draft gage. With coal of uniform size, the furnace draft therefore becomes an index of the condition of the fuel bed, which in turn is the controlling factor in the amount of air entering the furnace. A less resistance means more air, and a lower draft gage reading, whereas a thick, heavy fire means higher resistance, less air, and a higher draft indication. CO_2 is primarily affected by just these changes, so that if the furnace draft is calibrated in terms of CO_2, it becomes a reasonably good index of the gas analysis. Accurate calibration over an extended period, however, is quite necessary, always having in mind the size and character of the fuel. If the coal changes from slack to nut, or vice versa, recalibration must be made; but inasmuch as two or three grades of coal comprise the entire practical range, this does not involve a serious amount of work.

Another very valuable and significant indication obtained from the draft gage is the resistance that the boiler tubes offer to the passage of the furnace gases.

In any given boiler, the area between the tubes does not vary from day to day, except as it is affected by the deposit of soot or by the opening up of short-circuits in the boiler baffles. Furnace gases, passing through the spaces between the tubes, create a frictional resistance which retards their flow and results in a loss of pressure which is a direct index of the weight of gases flowing through the boiler. We have here, therefore, another significant indication which gives us a clue to the weight of gas, which, when the amount of air per pound of coal remains constant, becomes a direct indication of the amount of coal burned and substantially the rate of steaming of the boiler.

Now, assume the small plant where they do not care to expend much money and where the load is fairly constant day by day, we have a new combination which is suitable, as follows: Coal weights to each boiler, fuel bed resistance, as indicated by the furnace draft, and capacity, as indicated by the boiler resistance—another draft gage indication. This is reducing the problem to its lowest terms, and forms a combination which cannot be simplified and which no one is warranted in not adopting for reasons of cost, complication, or difficult operation.

The fireman does not necessarily have to know just what draft is, but if shown that a hole in his fire causes one gage to go down and the other to go up, and he understands that this is a bad condition, he does not need to be able to analyze it particularly.

This is not to be interpreted as an excuse for not using intelligence, but where we have the effect of its lack to contend with, we must, to a large extent, adapt the equipment to the intelligence which is obtainable.

In all the foregoing, I have endeavored to simplify the problem and confine my analysis to what might be classed strictly as instruments. There may be many variations or combination instruments which are obtainable and most useful, and it is not my intention to indicate in any way that these instruments should not be used where they properly apply. Such equipment as feed-water heaters, soot blowers, automatic draft controllers, feed-water regulators, etc., are not in my mind, to be classed as instruments, but rather as equipment, and essential equipment that, about which there can be but little controversy.

Improving the American Coal Situation

Possible Ways to Increase the Coal Production by the Introduction of Labor-Saving Machinery, and the Use of Coal at the Mines. By L. W. Alwyn-Schmidt

WE HAVE IT upon the authority of Lloyd George, the British Premier, that England will not be able to produce more than 200 million tons of coal during the coming 12 mo. and that even this much reduced quantity will not be reached by the employment of the same labor force that produced the 287 million tons mined before the war. Thirty thousand more men are working today in the English mines. American coal consumers complain about a falling off of the coal supply in all parts of the country, and the reports from the mines are very discouraging. This does not bode well for the industrial coal consumers of the world. The decline in the English production exceeds already the quantity that was exported by England before the war. Italy, France, Germany, South America, in fact, practically all the industrial countries of the world will see their coal supplies seriously reduced by the defalcation of England as a purveyor of coal, and it is difficult to see how any of these countries will be able to keep its industries going. The situation is one of prime importance to the whole world. It may involve a complete reorganization of the shipping situation of the world, and incidentally it has given the coal mines of America international importance. Will the United States come up to the expectations of the world or shall we fall down upon this important job of supplying warmth to the women and children and industrial energy to the factories of other countries?

The situation is no pleasant one to contemplate. Although rich in actual resources, we must acknowledge that our organization of raising and handling coal is not the best at present. With a great emergency before us, we are wasting our energies upon an unholy squabble between the agencies of production, capital and labor.

Let us not forget what our coal resources mean to our own industry today, as power producers, and by way of our industrial production to the well-being of a large part of the world. We are just passing through a period of intense anxiety as to the future of the international food supply. Lack of labor, unfavorable weather conditions, and other reasons, are continually shortening the small surplus that we thought had been accumulated following a rather good spring. Now on top of the food shortage comes the new fear of a coal shortage, just as serious and possibly still less bearable with its resultant decline of industrial production in the face of the ever rising cost of the product.

The European Market

With England out of the run for the supply of coal and whole Europe failing to take its place among the industrial producers, the consumers of the world are coming to this country for help. The market is provided for us. We may send commodities or if we choose, coal. All that is required now is that we provide the coal for the domestic as well as the foreign consumers. And it is here where we appear likely to disappoint our present and future customers.

As matters lie today, it is very doubtful whether we shall have sufficient coal for our own needs. Domestic and industrial consumers are endangered. Production is lagging behind in practically all coal fields, and the means of distribution seem to be insufficient to handle even normal quantities of coal in the Eastern direction, much less the large additional quantities which would be required for export purposes. Nevertheless even with these handicaps facing us, there must be found a way out of our difficulty. America can not afford to let this great need of the world pass unsatisfied, as long as it has the means of supplying it.

Raising more coal, sufficient to provide both for the domestic market and our foreign customers, is a matter of increased energy applied to our coal mines. Increased production, under today's conditions in the mines, demands the employment of more labor. With Italians, Hungarians and Bohemians returning to their countries at the present rate, and no new immigration in view, we are seriously handicapped in this respect. So far, we do not seem to have reached the state of affairs existing in England; but there is no denying that the labor situation is going rapidly from bad to worse, and that the day is near when any wage offer, however attractive, will not bring any more labor to the coal mines. The necessity may provide the solution of this side of the problem. We must find means to reduce the employment of labor.

Substitute Machinery for Labor

Human labor will never be excluded completely from work in coal mines. Neither can it be eliminated from any other industrial occupation, as the machines doing the work will have to be tended by somebody, but machinery must be introduced in ever increasing amount in the industry. Several propositions have been made to use the heating quality of the coal without mining it, by simply lighting the coal in its natural bed and collecting the gas. This system, however much it may appeal to the imagination of the man in the street, lacks the essential feature of conserving the transportable state of coal. Unless a far reaching invention is made, it seems to be impossible to transport coal gas over long distances; and, even if it should prove possible some day, in the haul of large gas containers, much on the lines of our oil tanks, there remains the problem, how to retail this commodity after its arrival. It might be discharged into large gas tanks in the towns, but it could not be handled similarly in small villages. The great ease of distribution of coal in its present form would be lost.

It is now proposed to coke the coal at the pit head or even below ground, and to turn the energy won in this way into electrical power which then can be distributed over wide areas. No doubt there is much in this new idea that deserves the attention of our power engineers.

It will readily be admitted that our present system of raising coal and distributing it is not the best possible; it is the result of long standing habit and has been continued, as there was nothing better to take its place.

That something better might be evolved has not been denied. The time seems now to have arrived when a radical change is required. Let us imagine for a while a situation as that now proposed in England, where large electrical power stations will be erected in the immediate neighborhood of the coal mines, supplying power to the mines as a matter of convenience, but constructed chiefly as a basis for a large electrical distribution scheme which is to cover the whole of England. There is no doubt that electrical equipment and electrical mining methods may replace much of the human labor employed in the coal mines, and it is only a matter of time until such equipment will be designed in a form that makes possible its industrial employment. Everybody even superficially connected with coal mining will understand that we could not even attempt to handle the present output of coal without the aid of the machinery at the command of our present day coal mines, and that hundreds of thousands of men would be required if we had to produce the same quantities with the equipment of a hundred years ago. Now, what has been accomplished by engineers in the past, certainly will be improved upon by the engineers of today and the future. New coal mining machines will be invented which will work as effectively as human labor, but reduce the actual employment of men to a minimum. These machines can be operated automatically by the use of electric conductors, controllers, and telephonic listeners. Powerful drills can dislodge the coal, and power shovels will load the cars that finally will be carried by electrically controlled wagons to the pit heads. This is no dream but a very simple matter if only we are sufficiently pushed by the increasing lack of labor.

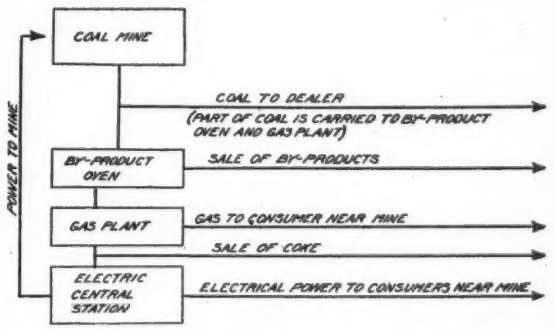
Power Houses at the Mines

Coal raised in this manner may either be shipped to the consumer in the usual way as practiced today, or it will be used in part at least by the large electrical houses that can be erected in the neighborhood. Here is an opportunity where we might improve on the English example. By injecting between the mine and the furnaces of the electrical power plants a gas making plant with a complete by-product plant attached to it, the coal might be used to its fullest capacity. The coal coming from the pits would be turned into gas after all the desirable by-products have been extracted. The gas then might be used for driving large gas motors which in turn would produce electrical energy. The cokes finally could be shipped to the iron furnaces or might be turned to good use in some other way that may suggest itself.

The saving of national energy in such a system would be considerable. It would eliminate the necessity of transporting at least all that coal which can be replaced by the direct supply of electrical power and by the use of wire transmission. Most of the work done to produce the industrial power from coal which is now distributed over a great number of production units, would be concentrated in one locality, in the immediate proximity of the mines. With an effort much below that expended at present, sufficient coal could be produced above the requirements of the American nation to provide all the export surplus needed to take care of the present European defalcation.

Of course, such a development can not be expected to be accomplished in a matter of a few years. Experience, however, has shown that great strides can be made in any given direction, if once the direction has been settled upon. So far we have not been able to take the decisive step, but we have proceeded far enough so as to know all the factors which must guide us in making the decision. These are simple enough.

The coal miners, coal distributors, and coal consumers of the United States are faced by a situation of extreme difficulty. The basic principles upon which the existence of our whole industrial life is built up seem to have broken down suddenly, and instead of the prosperity that appeared to lure us only a few months ago, ruin is looming ahead. A great chance has come to that nation of the world that can find the solution of the present problem. It is the problem of providing the means to continue production and to increase it if possible without adding to the number of operatives at present employed in the mines, or even under the necessity of decreasing their number. Distribution will have to be made more simple, and transportation must be provided for bringing the coal to the domestic consumers and for moving the surplus that may be made available for export, quickly to the countries urgently in need of it. We can not increase production and decrease at the same time the labor employed in coal mining without finding



SKELETON SHOWING POSSIBILITIES OF LOCATION OF POWER PRODUCERS AT THE MINE

some other means of doing the work. Only two processes are open, combustion or automatic working of the mines. If the known means of distribution, the railroads, fail, new means of distribution must be introduced. Coal turned into electrical power seems to be the best solution, with the possibilities of the gas generation and by-product plant as a side issue.

Financial Possibilities

If the whole program can not be executed at once, and nobody expects such a possibility, it can at least be taken in hand in part. The problem is not only one of production but also of finance. If the present difficulties are left to grow and the mines do not find a way out of the situation, the coal consumers of the nation will cry for some sort of relief. Pending any other suggestion, government ownership must come up again. By increasing the efficiency of the mines, by adding to their income the earning power of the electrical central stations and the very important by-product plants, new outlets for the investing power of the coal mine are found, holding the hope for new financial profits. It is a case

of bringing the coal mine up to the demands of a period which, in fact, has already far outdistanced the present system of mining and distributing coal. Let a beginning, therefore, be made with such a policy, and if a start must be suggested, let it be with the erection of electrical power stations as already provided for in other countries, so that the employment of additional labor saving machinery can be approached in a proper manner.

The effect will soon show. As the first and most outstanding result there will be a relief of the railroads in the near neighborhood of the coal mines, which are today partly responsible for the congestion of the coal traffic of the country. Coal will flow more easily and in greater quantities to the coal consumers at the thousands of distributing points of the country, outside the range of the power station. The industrial consumer, the gas plant, the electrical stations, the local trolley lines, and all the other consumers of coal in large and small quantities are vitally interested in the success of such a scheme.

No doubt the dealer is suffering very heavily under the present condition. Unable to aid production himself, caught between the unwilling worker of the mines and the discontented consumer; he waits for the railroads to bring him the expected supply of coal. Clear for once the traffic congestion around the mines and make possible the free movement of coal cars in every direction; coal then will move freely to the dealers, eliminating the unpleasant delays of today and the necessity of keeping large stocks of coal on hand in preparation for the eventuality of a stop.

Most power producers buy their coal from the dealer. Their interest in the coal trade and its future development, therefore, is not entirely of a humanitarian character. If the present condition continues and the coal trade is permitted to relapse into a state of coma, conditions will return very similar to those of two years ago, when our whole industry seemed to be endangered, owing to inability of the coal dealers to produce the necessary coal. The labor situation in the coal mines and everything resulting from it, therefore, is by no means a problem concerning the mines and the coal trade alone. It is one that concerns increasingly the power industry of the United States; in fact every industrial enterprise, and ultimately every individual citizen. A satisfactory solution of the coal problem is absolutely necessary to the smooth operation of our economic life during the reconstruction period, and a disturbed coal situation during the coming winter will mean not only a serious disarrangement of our industrial activities, but it may spell far reaching distress with social unrest following in its wake.

The power industry and the industrial power consumer, being the biggest group of coal consumers in this country, should make their voice felt. If the problem of the coal industry can be relieved by the application of technical means, these means should be provided. It seems that our power engineers being interested in the problem as consumers, as well as constructive thinkers, might find a fertile field for their inventive genius in providing for equipment likely to improve American coal production, if necessary to a complete, or as near as possible, complete exclusion of labor from this field of production.

Stress in Steam Pipes

CALCULATING STRESS DUE TO HOOP-TENSION, AND COMBINING WITH THAT DUE TO BEAM ACTION. MATHEMATICAL AND GRAPHICAL METHODS. BY H. M. BRAYTON

IN a previous article on this subject, the writer showed methods and charts for the rapid determination of the stress created in the steam pipe due to beam action. These methods serve, as was pointed out, as a scientific basis upon which to select the proper spacing of steam pipe hangers.

The stress due to beam action is not, however, the only stress to which the metal is subjected. The fluid pressure due to the steam creates a hoop-tension which in the case of high pressures and large pipe may be considerable. Both of these important stresses must be determined mathematically and combined vectorially to find the true stress in the metal.

HOOP-TENSION

HOOP-TENSION IS the stress produced within the metal of a circular pipe due to internal pressure. This tension tends to pull the pipe apart and if its value exceeds the strength of the metal, the pipe will fail. This stress acts in a plane perpendicular to the axis of the pipe, hence at right angles to the stress due to beam action. Ordinary pipe may be classed as a thin hollow cylinder, in which case the following formula gives the value of the stress:

$$F = PR \div T \qquad \text{(Eq. 1.)}$$

in which F = Fiber stress in pounds per square inch.

P = Internal pressure in pounds per square inch.

R = Internal radius in inches.

T = Thickness of pipe wall in inches.

If one has occasion to use this formula from time to time, it will save time and insure accuracy to build it up into a simple chart which will give the stress instantly. Such a chart is shown in Fig. 1. This chart is built up for "extra strong" wrought pipe. The reader may build up one for himself for any kind of pipe which he may have occasion to use often. All one has to know is the size of the pipe and the internal pressure to obtain the fiber stress in the metal due to this pressure. The dot-dash line on the chart shows how to use it. As an illustration an 8-in. pipe and 200 lb. per sq. in. pressure have been selected. Simply find the size of the pipe on its scale at the left. Travel up until the irregular curve is reached, then over to the given pressure line and then down to the stress scale. In the illustration given the stress comes out 1525 lb. per sq. in. The reverse will, of course, also hold if one desires to know the size of pipe which will give a certain stress with a given pressure.

METHOD OF CONSTRUCTION

IT WILL BE remembered that the chart given applies

only to "extra strong" wrought pipe. In order to enable the reader to build his own chart for whatever pipe he may be working with, the writer will outline the methods used in construction. From a table of pipe dimensions, secure the inside and outside diameters of each size of pipe. It will be well to make a table giving in addition to dimensions the quotient of the radius R divided by the thickness T.

Equation 1 contains four variables. It may be reduced to three if we write it thus,

$$F = \text{PR} \div T \qquad \text{(Eq. 2.)}$$

in which we may consider the ratio of the internal radius of the pipe to the thickness as one of the variables. With this information and the table given we may proceed to plot the curve shown on the left of the chart in Fig. 1. This curve is plotted with the size of pipe, shown in the first column, as the abscissa and the values of $R \div T$ shown in the last column as the ordinate. The right-hand part of the chart may next be

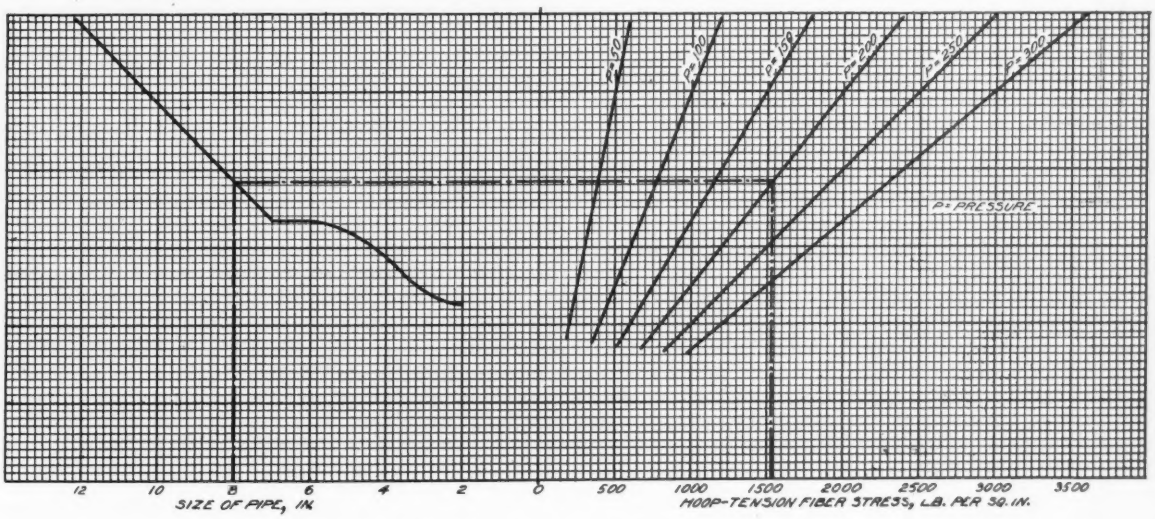


FIG. 1. CHART FOR CALCULATING HOOP-TENSION IN "EXTRA STRONG" WROUGHT PIPE

drawn from the formula given above (Eq. 2). Substitute a value for P such as $P = 50$ lb. The formula then reduces to

$$F = 50R \div T$$

which is the equation of a straight line through the origin. Draw this first line and mark it $P = 50$ and then proceed to draw the others with the various values for P. The vertical scale through zero for the ratio $R \div T$ need not be put on the chart as we are not interested in this ratio except as it is necessary in construction. It is further not necessary to draw all the pressure lines to the origin as they are of no value below the lowest point of the curve at the left.

This chart may be drawn to any scale and size desired by the reader and if placed in a convenient place will be found of great help to the man who is constantly called upon to calculate this stress.

Resultant of Two Stresses

It has been shown above how to calculate the stress in a steam pipe due to internal pressure and in a previous article how to determine the stress due to beam action. In order to obtain the actual magnitude and direction of the resultant stress, we must combine these two separate stresses vectorially. If both of these stresses acted in the same plane, it would be simply a case of adding them if they acted in the same direction

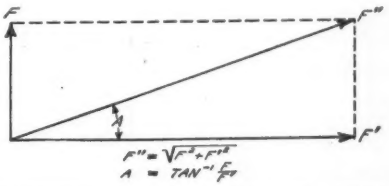


FIG. 2. COMBINING BEAM ACTION AND HOOP-TENSION STRESSES VECTORIALLY

or subtracting them if they were in opposite directions in order to derive the resulting stress. These two forces act in planes at right angles to each other. Figure 2 shows a sketch of these forces. If we let F equal the stress due to internal pressure and F' the stress due to beam action, we may write for the resulting stress F'',

$$F'' = \sqrt{F^2 + F'^2} \qquad \text{(Eq. 3.)}$$

This formula can be readily solved with an ordinary table of squares. It may be desired to obtain the direction of the resultant in which case we simply write,

$$\text{Tan. } A = F \div F' \qquad \text{(Eq. 4.)}$$

DIMENSIONS OF "EXTRA STRONG" WROUGHT PIPE

Size inches	Outside Diam. D, inches	Inside Diam. D, inches	Inside Radius R, inches	Thickness T, inches	R ÷ T
2	2.37	1.94	0.97	0.22	4.50
3	3.50	2.90	1.45	0.30	4.84
4	4.50	3.85	1.92	0.34	5.72
5	5.56	4.81	2.41	0.38	6.42
6	6.63	5.76	2.88	0.44	6.62
7	7.65	6.65	3.32	0.50	6.62
8	8.63	7.63	3.82	0.50	7.62
9	9.65	8.63	4.32	0.50	8.60
10	10.75	9.75	4.87	0.50	9.75
11	11.75	10.75	5.38	0.50	10.75
12	12.75	11.75	5.88	0.50	11.75

where A = the angle which the resultant stress makes with the axis of the pipe.

A liberal factor of safety should always be allowed in work of this kind. A factor of 8 is small enough to apply in such cases; more if possible.

The Steam Engine Indicator Diagram---II

Analysis of the Expansion, Release, Exhaust and Compression Lines

AFTER the point of cutoff has been reached, expansion is the next logical event. How efficiently this is carried out in the cylinder, can be determined only by a comparison of the shape and position of the actual indicator line as compared with the theoretical line, this being drawn through points properly located on the diagram.

There are several ways of going about this, although the method to use depends entirely upon the point to be determined. The amount of work done by the steam used in a given stroke is of prime importance at all times, so this will be considered here.

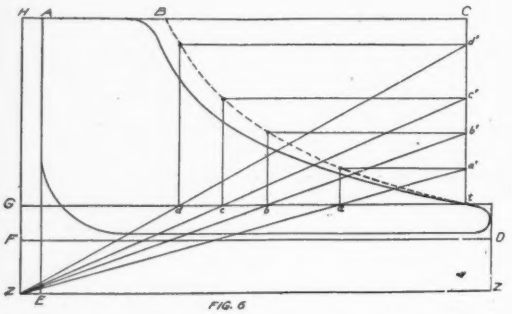


FIG. 6.

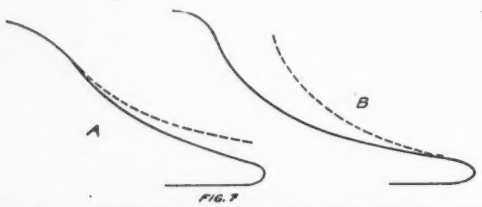


FIG. 7.

FIG. 6. CONSTRUCTION OF IDEAL EXPANSION LINE
FIG. 7. TWO BADLY FORMED EXPANSION LINES

Referring to Fig. 6, select the point t on the actual expansion line as the place where the exhaust valve opens. Draw vertical line AE. Lay off EZ equal to the clearance in terms of piston displacement and draw vertical line ZH, which is the ordinate of zero volume. Through t draw horizontal line tG, and vertical line tC. From Z draw radials Za', Zb', Ze', Zd' at random and erect perpendiculars from the points where the radials intersect tG, a, b, c, d. The intersections of these perpendiculars with horizontal lines from a', b', c', d', are points on the true hyperbolic expansion line for the given diagram.

The actual expansion line is the one part of any card which an engineer should view with a great deal of decision before adjusting his engine. Dry steam and a late cutoff are conducive to curves closely approximating the theoretical; but expansion ratios, methods of insulating cylinders, re-evaporation and many other features peculiar to individual installations, all tend to mislead and some give indications of ailments which really do not exist.

Re-evaporation is an important factor in keeping up the pressure ordinates. The law of pressure times volume equals a constant is approximated in an actual card, since, as the steam enters the piston, some of it condenses and gives up part of its heat to the piston and cylinder walls. As the piston moves outward, the cylinder pressure is lowered and then comes a point when this condensate again goes into steam, a re-evaporation due to low pressure and the available heat remaining in the metallic parts. So it is, that throughout the expansion process, the deviation from theoretical law is approximately offset by re-evaporation, and the actual and the theoretical lines are made to coincide nearly, except where other causes enter in.

The actual curve falling below the theoretical as indicated in Fig. 7-A is an indication of leakage through the exhaust valve, if this is actuated independently of the inlet, or past the piston, due to defective rings. Leakage into the cylinder through the steam valve will sometimes make up for this loss; so unless there is a great imperfection somewhere, it may not show. A good check for defective piston rings is to compare cards from both ends of the cylinder. Very seldom will a leaky inlet valve be present in duplicate to the same degree, while an imperfect ring will allow steam to pass in either direction.

The marked deviation as shown in Fig. 7-B indicates at once an imperfect inlet valve which admits steam after cutoff in sufficient quantity to bring the cylinder pressure up to the theoretical even though the two lines were widely separated to start with. These gradual changes in the direction of the curve are seldom due to defective valve setting.

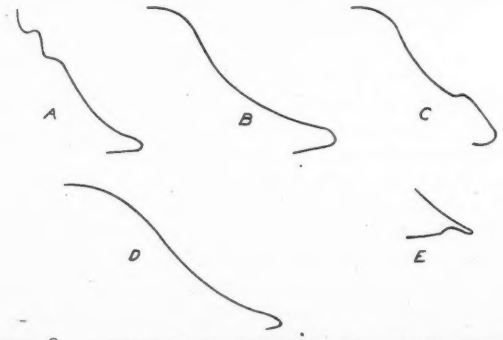


FIG. 8. A NUMBER OF DEFECTIVE EXPANSION LINES

Figure 8-A indicates a reopening of the valve after cutoff, due, usually, to defects in the valve gear or seat. Back expansion valve equipment sometimes gives trouble in that the expansion valve re-opens the port in the inside slide before the cylinder port is closed. This trouble gives lines similar to Fig. 8-B and C. If the rod or valve binds in ordinary slide valve construction, the valve is apt to be lifted entirely off its seat which admits steam and causes a jump in the pressure line. A complete reversal of the expansion curve, either under, over, or equally distributed, about the theoretical curve, indicates valve leakage throughout the whole stroke, Fig. 8-D. Figure 8-E indicates an arrangement

of the valve gear which gives release after the end of the stroke.

The Release Line

The point of cutoff and the piston speed are the two main deciding factors in the shape of this part of a diagram. Figure 9-A shows what may be expected from a slow moving engine where the point of release is carried right up to the end of the stroke. In some engines it is not desirable to do this, since back pressure will be increased if the exhaust valve is not fully opened before the piston reverses and the partially expanded steam given a chance to flow out unrestricted. In Fig. 9-B the dotted lines indicate the form of diagram obtainable from such an engine when no opening is permitted until the stroke ends, while the full lines indicate the result of an early release at point p. It is evident that the gain in power represented in area a, b, c, more than offsets the loss of p, d, a. The location of part p along the stroke is of much importance in condensing units if the benefit of the vacuum is to be realized.

Figure 9-C shows a failure to get all of the work possible out of the stroke since at its reversal, work was required to eject the steam contained, the pressure not becoming normal until point a was reached. An earlier release would remedy this, as shown in Fig. 9-D, where

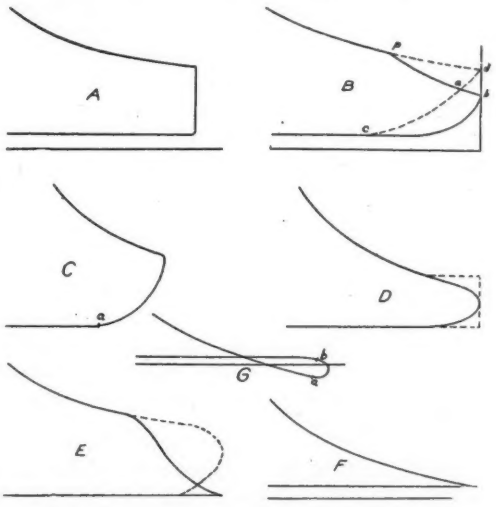


FIG. 9. RELEASE LINES, GOOD AND BAD

half the pressure drop is obtained before the stroke ends, and the remainder on the reverse stroke. An instance where the stroke occurred much too early is shown in Fig. 9-E. The available work could have been increased by an amount proportional to the dotted line areas had the valves been properly set. Figure 9-F is an instance where the terminal pressure is equal to the back pressure.

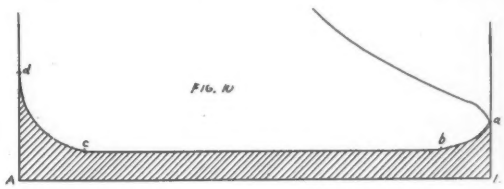
Exceedingly early cutoff resulting in a drop of cylinder pressure below the back pressure is indicated in Fig. 9-G where the release line ab is drawn in a negative direction.

The Exhaust Line

For diagram analysis it is sometimes convenient to consider the last half of the release line, the exhaust line, and the compression line as one complete part of the cycle, since they all represent conditions existing during the return stroke of the piston and are more or less dependent on each other.

From a standpoint of power available, it is always good policy to make the area represented shaded in Fig. 10, as small as possible. The back pressure line bc should coincide with the atmospheric line AL (in noncondensing engine) and the curves ba and cd should take as far as possible the shape of the right angle dAL and aLA.

An unrestricted exhaust port area will permit a closer relation of bc and AL, to good advantage, but radical changes in ab will have to be brought about by reducing the forward pressure and to change cd will



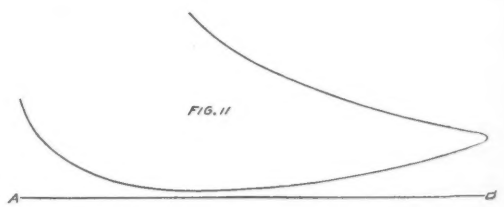


FIG. 10. AN AVERAGE EXHAUST LINE

FIG. 11. EXHAUST LINE CAUSED BY RESTRICTED EXHAUST PORTS

involve the use of a larger quantity of steam to fill the clearance space thereby reducing the work per pound of steam used. Absence of the heating effect due to compression and the loss of a desirable cushion effect, just previous to the piston reversal are also important factors to consider. Thus we see that a reasonable amount of curvature at each end of cb is desirable and while some power is lost, as shown by the black area, this is not appreciable as compared with the advantages gained.

In noncondensing engines where the exhaust port areas are restricted, it is a common condition to have a slanting exhaust line, Fig. 11 starting in considerably above the atmospheric line AB and gradually approaching it as the spent steam finds its way out. In condensing units the location and direction of this line depends entirely upon the condition of vacuum in the condenser.

In Fig. 12 AL represents the atmospheric pressure, ST the vacuum existing in the condenser, and ZZ′ the perfect vacuum line.

Ordinarily exhaust lines as shown in Fig. 10 and 12 are met with, but occasionally an imperfect one does show up, as in Fig. 13. Here the exhaust line for one end of the cylinder closely approaches the proper position and shape, but that for the opposite end shows a sudden pressure drop after part of the stroke has been completed. This discrepancy is due to unequal valve travel, the exhaust opening being more than required at one end, and therefore not enough at the other. Unless the valve had unequal outside laps unequal degrees of cutoff would also exist. Figure 14 is also an ordinary form met with in practice, which indicates a throttling

of the exhaust as the valve reaches the limit of its opening. Over travel of the valve or addition of inside lap in order to give compression will cause this trouble.

In installations where one exhaust pipe takes care of two cylinders with the cranks at right angles, this form of line is frequently met with. A sudden release of steam from one cylinder causes an increase of back pressure in the other just as it is in mid-stroke. This

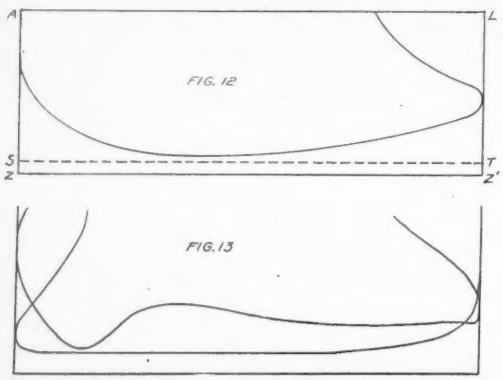


FIG. 12. EXHAUST LINE OF CONDENSING ENGINE
FIG. 13. EXHAUST LINE CAUSED BY UNEQUAL VALVE TRAVEL

acts on the indicator piston and causes a momentary rise, as in Fig. 14.

In locomotive cylinders where the cutoff occurs late and the release pressure is high, this form of exhaust line is frequently found. Figure 15 is a case where the slide valves have different laps. In one end, release is delayed and compression pronounced, while in the other release

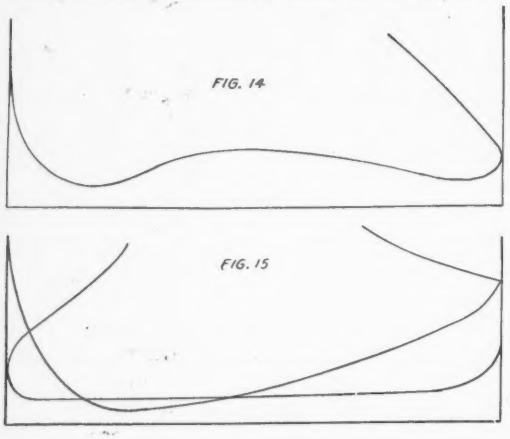


FIG. 14. THIS SOMETIMES APPEARS WHEN TWO CYLINDERS AT 90 DEG. EXHAUST INTO THE SAME PIPE
FIG. 15. A SLIDE VALVE WITH UNEQUAL LAPS MAY CAUSE THIS

is early and compression much less pronounced, all other events taking place at the proper time.

The Compression Line

One of the main advantages of compression in a steam engine is the cushioning effect it has on the moving parts just before they come to rest for reversal. High-speed engines are characterized by their high compression, while low-speed units are designed for a lower compression. The conditions are ideal for smooth operation, all jars and sudden changes of direction being deadened by the compressed volume of steam. There is a great difference of opinion as to just what the percentage or amount of compression should be. As a matter of fact, this figure is not readily ascertained.

An engineer will do well to follow the engine manufacturer's instructions on this point, or, if they are not available, size up conditions after making several cards and considering the smoothness with which the engine parts reciprocate at each stroke. Theoretically, the line should follow the path of a true hyperbola connecting the exhaust and steam lines. Practically, it is sufficient if it is a smooth, gradually curving line with no irregularities.

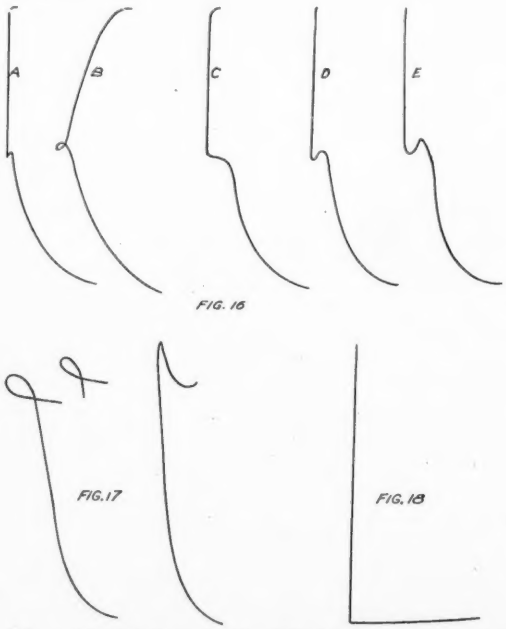


FIG. 16. COMPRESSION LINES INDICATING CONDENSATION
FIG. 17. INDICATING RATHER LATE AND HIGH COMPRESSION
FIG. 18. A RARE CASE, INDICATING NO COMPRESSION

Excessive compression is indicated by the lines of Fig. 17. These show that the pressure at the time the inlet opens is in excess of the cylinder steam pressure. To do away with the hooks a slightly earlier point of compression should be taken advantage of. Very seldom is a card made where the compression curve is lacking as in Fig. 18, since this card would indicate absolute absence of cylinder pressure at the time the inlet opened. Sufficient steam is usually left in the cylinder to give a well rounded corner.

Compression lines as shown in Fig. 16 may be laid to a condensation of the compressed steam, just previous to the inrush of new steam which again starts the curve upward; or piston or valve leakage. Condensation is usually indicated by A; this condition coupled with a late admission is shown by B, and serious leakage is indicated by the forms C, D and E.

All leaks being absent, compressed steam with little or no condensate makes a good appearing compression curve, and from this it follows that high speed jacketed cylinder engines ought to produce better compression curves than slow speed engines, where the cylinder is exposed, allowing considerable heat to get away.

EDWIN H. PERRY

How Superintendents Are Developed. By Devoted Study and Excellent Work, This New England Farm Boy Gained a Responsible Position. By Joshua O'Leary

NEW ENGLAND farm life, with its traditional moral standards, its spirit of virile and intelligent enterprise and its wholesome social conditions, has been an important factor in the growth and power of the United States.

The "woods and templed hills" of New England have been represented in every phase of American progress by men who in their various fields of activity have "made good." Its youths and maidens have been well described by Whittier as "sturdy boyhood, sun embrowned, and girlhood with its solid curves of healthful strength and painless nerves." Amid such conditions and environment Edwin H. Perry was born on a farm in Woodstock, Connecticut.

His early education was obtained at the town public school and, though the curriculum and school methods of the period would not be acceptable to educators of the present day, still the mental equipment of young Perry and his classmates after going through the courses in the grammar school would compare favorably with that of the average graduate of the modern high school.

EDWIN H. PERRY

Like so many other farmer boys, Edwin Perry longed for winder fields of action than were offered by farming on the scale afforded by his home town. A born mechanic, his early ambition was to become a railroad engineer. His plans in this direction, however, were frustrated by the death of his father, which occurred when the young man was 17 yr. old. This sad event threw upon him the care of his mother and two sisters, but he met the new responsibilities with the same fortitude and cheerful determination that have marked his onward and upward progress in the business that subsequently became his life work.

Young Perry entered stationary engineering on the bottom round of the ladder, first as assistant fireman and afterward fireman in a factory at Putnam, Connecticut.

Early he realized the truth of the proverb that knowledge is power and, though obliged to discharge his daily task, he determined to prepare himself to achieve a larger success. Accordingly he devoted all available time to the acquisition of practical knowledge and completed a course in steam and electrical engineering with a leading correspondence school.

As a result of his application to study and the gaining of practical experience, the young engineer was soon enabled to take full charge of the power plant of a mill in Putnam, and, having made a success of his work there, he obtained a position as assistant engineer at the plant of the Electric Light Co. at Worcester, Mass., where he remained 5 yr.

Mr. Perry's next move was a further advancement. He was given charge of a new power plant in Millbury, where he had a 6000-kw. generator, the largest in Worcester County at that time.

In 1911 he returned to the Worcester Electric Light Co., taking a position as engineer at their great modern plant, which was started the previous year. He remained with that company till 1914, when he went to Webster, Mass., to take charge of the electric light plant there, which, under his direction, was nearly doubled in capacity and brought to a high degree of efficiency. His splendid work there resulted in his return to the plant of the Worcester Electric Light Co., in March, 1917, as chief engineer.

Of course, the war conditions which ensued and affected so seriously all the power plants of the country, greatly increased and complicated the problems confronting the new chief and his associates, but these problems, among which combustion and conservation of coal were the most pressing, were successfully solved by the ability, skill and effective team work of Mr. Perry and his loyal co-workers.

After filling with high efficiency the position of chief

engineer until a vacancy occurred, he was advanced to the superintendency of the plant, which position he now holds to the entire satisfaction of the general management of the company and with most cordial support and good will on the part of the competent and well-organized force operating under his direction.

To young engineers the story of Mr. Perry's progress in his chosen career should prove instructive as well as interesting. His success was not obtained by accident or influence. Faithful and efficient work in each position in which he served and intelligent preparation through study and added experience for rendering valuable service in positions higher up, have been the firm rungs in the ladder by which he has mounted to the top in what may justly be called the engineering profession.

Those who have been close to Mr. Perry, whether as managers, associates or subordinates, attribute to him two characteristics which are specially notable. These are his genial disposition, which accounts largely for his harmonious management of men, and his resourcefulness in pulling out of plant troubles.

In power plants, especially in those of large size, continuity of service is of the first importance, and the man who can manage to pull out of trouble without a "shut down" wins the admiration of the men, as well as the commendation of the management.

Mr. Perry, according to those who have been associated with him, possesses these qualities in a high degree, and while his other characteristics may sufficiently account for his success, those two easily explain his undoubted popularity with the entire force under his charge.

Mr. Perry is still a young man, as age goes among men who have gained eminence in their calling, and his experience affords an inspiration as well as a lesson to those whose feet are entering the path that leads to honorable and enduring success.

Careful Belt Computations

By W. F. Schaphorst

THERE was a time when we didn't have to be so careful with our dollars as far as belting was concerned. Leather costs so much now, though, that we cannot economically use the old rule of thumb that would fit "any" case. In old days we figured for a belt that would transmit the load no matter what the size of the pulleys, distance between shafts, speed of belt, or anything of that sort. Times have changed. Let's see what must be done now in order to be up-to-date.

The old rule for single leather belts was this: "Multiply the horsepower to be transmitted by 800 and divide by the speed of the belt in feet per minute." The answer gave the width of a single belt in inches. It was a good "safe" answer.

It gives a belt, however, that is "too safe" for our modern pocketbook under certain conditions. For example, let us suppose that there is a very little difference in pulley sizes and that the smallest pulley is not smaller than 16 in. in diameter. Let us suppose, also, that the speed of the belt is not greater than 3000 ft. per min., that the shaft centers are at least 10 ft. apart, that the belt is horizontal or does not incline or slant more than 45 deg. with the horizontal, that the drive is not of a jerky nature and that the bottom side is the pulling side. In such a drive, you see, conditions are almost "ideal" and a narrower belt can be used to good advantage without impairing the efficiency or safety of the drive. Under these conditions (as enumerated in this paragraph) the rule becomes, "Multiply the horsepower to be trasmitted by 476 and divide by the speed of the belt in feet per minute." The answer gives the width of a single leather belt in inches. If it is a double belt instead of a single, multiply by 0.625. If it is a triple belt instead of a single, multiply by 0.5. In other words, a double belt need be only ⅝ as wide as a single belt, and a triple belt only ½ as wide as a single belt.

Take another case, now, where conditions aren't quite so ideal, but where they are definitely known. Let us suppose that the small pulley in the drive is at least one foot and the large pulley no larger than three ft. in diameter. The speed must not be greater than 4000 ft. per min., The belt must be horizontal or incline not more than 60 deg. with the horizontal. The bottom side must be the pulling side. The belt should not be subjected to jerks, and the shaft centers should not be closer than 8 ft. Under conditions enumerated in this paragraph, then, the width of a single leather belt is found as follows: "Multiply the horsepower to be transmitted by 572 and divide by the speed of the belt in feet per minute." And again, as explained above, a double belt need be only ⅝ as wide as a single belt, and a triple belt only ½ as wide as a single belt to transmit the same power.

Where speeds are greater than 4000 ft. per min., where there is a greater difference in pulley diameter than included in the above special cases, where pulleys are closer together, etc., it is still necessary to fall back on the old rule of thumb first given.

If you already have a belt of given width and thickness and wish to determine the horsepower it will transmit, or the speed it must be run at in order to transmit a given amount of power, it is a simple matter to make such determinations from the rules given above by working them "backward."

New Cobalt-Nickel Alloy

THE French Thomson-Houston Co. has been granted the French patent No. 487,164, June 12, 1918, for a new alloy of nickel and cobalt. This alloy contains from 20 to 30 per cent of cobalt and from 70 to 80 per cent of nickel, together with a small quantity of manganese. It is found to be much less brittle at ordinary temperatures than the cobalt-nickel alloys heretofore in use. In addition, it can be easily drawn, and can be rolled in sheets as thin as a half millimeter (0.02 in.) without previous tempering. It is a poor conductor of heat, has high fusion point, over 1500 deg. C. (2732 deg. F.), feeble tendency to vaporize or become dissociated electrically, does not oxidize, is a good conductor of electricity and solders easily. These qualities render it especially suitable for the supports for the filaments in incandescent lamps, on the efficiency of which the low temperature of the supports and current wires has a great influence, seeing that the electrical resistance of a conductor is increased by any increase of temperature.

Lubrication

VARIOUS KINDS OF OIL USED. TYPES OF FILTERS. LUBRICATION OF STEAM AND GAS ENGINES. BY JOHN D. MORGAN

A GREAT number of oils contain impurities due to improper methods of refining, and others actually have a number of harmful ingredients added to them. Quite often soap in some form or other is added to the oil as a thickener and caoutchouc is often added to produce a high viscosity. Every refiner has ideas about compounding his oil, and it is quite likely that some refiners try to disguise their oils for the purpose of deceiving other refiners; however, the use of compounded oils is a necessity in a great many cases.

The most frequent adulterant of lubricating oils is finely divided graphite. The effect of the addition of graphite is as follows: (1) The value of or for the internal friction remains fairly constant for oils whether treated with graphite or not. (2) The mechanical friction of heavy oils is lowered somewhat by the addition of graphite. (3) The addition of graphite in some cases does produce a noticeable economy in the oil consumed; however, after a prolonged use of graphite the pores of the iron become filled and it is impossible to keep any oil in the cylinders.

Solid fats and greases are useful for lubricating machinery in places where fluid lubricants will not hold. It is necessary in the use of these solid fats and greases that the surfaces or parts requiring lubrication should be brought by friction to the temperature at which the grease or fat melts. This has the disadvantage that solid fats and greases only provide lubrication when a certain amount of heat has been developed in the bearing.

Castor oil is not to be recommended, as it is a great waster of power, for it increases the friction once again as much as that produced by a high-grade engine oil. It has been claimed by a great number of authorities that fatty oils are superior in lubricating properties to mineral oils. This generally is not an accepted fact, but it is certain that the addition of animal or vegetable oils in small quantities to mineral oils for certain classes of work does improve the lubricating qualities of the mineral oil, and it is an acceptable fact that lubricants whose basic ingredients are mineral oils are the lubricants which are best adapted to all forms or classes of lubrication.

DESIGN OF OILING SYSTEMS

IT HAS been customary in power plants to pay little or no attention to the design of the oil piping, and in most cases the cost of the oil piping will be as great as that of the blowoff piping and much greater than that of the drips and drains piping. It is a fair assumption that in stations where engines are the generating units, the oiling system piping will amount to 2½ per cent and in turbine stations about 4½ of the total piping cost.

The material used in oiling systems has been given very little attention, and as a result the lubrication engineer has had many difficult lubrication problems to solve. For it is now a well-known fact that when turbine oils or their equivalents have been exposed to heat, air and moisture, as they are in the modern circulating oil systems, and when this system is composed of two or more metals of different potentiality, such as brass pipe, copper pipe, brass netting or cloth, galvanized iron, etc., the oils are broken up quite rapidly, due to electro chemical galvanic actions and reactions, and catalytic actions, that affect the different metals as soon as an electrolyte is formed in the oil system by the oxidation of petroleum oils in the presence of heat, air and moisture. When this stage has been reached, the oils begin to break up rapidly, forming petroleum acid, acidation and polymorisation products. These partly become insoluble and are thrown out in the form of muck, so frequently found in oiling systems, but part of them remain in solution. Besides the chemical and physical changes that take place in the oils, more or less corrosive action takes place in the metals. Numerous experiments have demonstrated the fact that the piping should be of one material and that the one metal that is best suited is iron.

In the design of the oiling system one must, of course, figure on the use of filters for the returned oil. There are a number of filters on the market which are quite satisfactory. It will be found, however, that in a large station it will be better to design the filter to meet the individual plant conditions. A good design is one made up of plate iron having a long rectangular tank for the returning oil. From this tank the oil flows to trays filled with canton flannel filtering bags, and from these bags to a large storage tank, where it is cooled by means of cooling coils. The approximate cost of a filter of this type of a five-tray (90 bags per tray) capacity and having a storage tank for filtered oil of 3½ by 5 by 19½ ft., fully equipped with gage glasses, piping, cooling coils, etc., is about $2000.

In plants and round houses where considerable oil is thrown into the cooling water or sewage, it will pay to install concrete tanks and traps to catch the oil. These traps should be divided into compartments by means of baffles and also used for checking the flow of the water and allowing the oil to rise to the surface, and in the final compartment the oil can be scooped from the surface of the water.

The design of storage tanks for lubricating oils should have careful attention given to the following points: (1) absolute cleanliness; (2) that overheating of the oils does not occur; (3) that air is not permitted undue access to the oil; (4) that the storage tanks are not located where the formation of ozone is likely to occur, as ozone in the air increases the rate of sludge deposit; (5) that the oil does not come in contact with clean surface of copper or lead, for copper has a pronounced effect on the sludge deposit, and the greater the copper surface exposed, the greater the rate of sludge deposit. Copper, as a rule, does not enter into the composition of the deposits and it is only very slightly attacked in a corrosive manner, but rather plays the part of a catalytic agent. Lead and zinc show signs of corrosion

and enter into the composition of the deposits, which are of a characteristic pale yellow color.

Lubrication of Journal Boxes and Armature Bearings

The lubrication of journal boxes and armature bearings by means of oil and waste has proven extremely successful, and is at the present time the best method of lubrication for such conditions.

The essential feature of efficient lubrication is to use a good grade of wool waste, with a small amount of Japanese fiber added to increase the elasticity, and to have the material properly saturated with oil. The oil used must not be too light, lest the film thickness be too small and cause bearing wear, but the oil must flow freely. The proper method of saturating the waste is to have a cage made and immerse the cage containing the waste in the oil for at least three days, then remove the cage and allow the oil to drip for about 12 hr. By this method a uniform feed of the oil by capillary attraction is assured. In packing the boxes the waste should be formed in loose balls of a size suitable for insertion or removal without undue force. It is generally unsatisfactory to add free oil to the waste when it becomes dry, but rather that the boxes should be repacked. The main features to watch in this type of lubrication are: (1) that boxes are properly packed; (2) absolute cleanliness; (3) uniform or stated intervals for repacking boxes; (4) never to pack boxes until journals and brasses are cool.

The general amounts of oil and good wool waste used per box for various journal sizes are as follows: 5½ by 10-in. journal, 2½ lb. of waste, 5 qt. of oil; 5 by 9-in. journal, 2¼ lb. of waste, 4½ qt. of oil; 4¼ by 8-in. journal, 1¾ lb. of waste, 3½ qt. of oil, while for a cheap wool and cotton waste the following amounts are required: 5½ by 10-in. journal, 2¾ lb. of waste, 5½ qt. of oil; 5 by 9-in. journal, 2½ lb. of waste, 5 qt. of oil; 4¼ by 8-in. journal, 2 lb. of waste, 4 qt. of oil. It will be self-evident that the use of good waste and wool will result in a financial saving in packing alone of about 15 per cent, besides insuring better lubrication throughout.

Lubrication of Internal Combustion Engines

The lubrication of internal combustion engines requires a good quality of mineral oil, entirely free from any animal matter or other ingredients that will tend to coat the cylinder walls. For the best results with the use of a minimum amount of oil, the oil should be introduced at the end of the power stroke, for that will give three strokes before the burning gases would affect it. Much of the back firing, or, rather, pre-ignition, in internal combustion engines is due to improper lubrication, and any random way of lubricating the cylinders is a waste of oil and a cause of trouble. Quite often a source of trouble in lubricating internal combustion engines is caused by the leakage of fuel past the piston rings, mixing with the lubricating or cooling oils; this has the effect of reducing the flash point as well as the viscosity.

Lubrication of horizontal and cylindrical bearings is best accomplished by a continuous flow of the lubricants. This, of course, will necessitate the use of an oiling system, whether it be self-contained or part of the station. Great care must be exercised in its design, and in general it will be found wise to construct the entire system of black iron pipe, irrespective of the fact that polished brass and copper pipes look better.

In the design of horizontal bearings due consideration must be given to the importance of heat conduction, of the pressure in the bearing due to the centrifugal force, and especially to the partial or segmental contact in bearings. In cylindrical bearings the elasticity of the lubricant must be considered, for its general effect is to displace the position of minimum pressure in the direction of motion and to decrease the total range of pressures. In the lubrication of this type of bearing a lot of discussion has been heard in regard to the film thickness. This point can be disposed of by the simple fact that the film thickness increases with the speed and viscosity and decreases with increase in load.

There is one point in the lubrication of bearings of an electric generator that must be given very careful attention, and that is the matter of stray currents, which produce paralysis of the oils. These currents can be overcome by the proper insulating precautions being taken on the bearing pedestals, etc.

It is quite common practice in all oiling systems to use the oil over again after it has been cooled and filtered. The effect on the lubricant is that the density and viscosity show a slight increase, compared to new oil, and the friction coefficient for low pressures becomes smaller, while for higher pressure it increases. In general, it can be said that if lubricating oils are not heated above their flash point, their viscosity and lubricating properties will not be changed, although some of the lighter oils may be distilled off. Subjecting the oils continuously to a heat less than their flash point results in an increase in viscosity, although the flash point remains practically a constant.

Lubrication of Steam Cylinders

The lubrication of steam engine cylinders has been one of the first problems of the lubricating engineer. With low speeds, low steam pressures, and plenty of moisture in the steam, the lubricating problem was not acute. Times changed, however; high speeds, high steam pressures and efficient boilers were introduced, and immediately lubricating troubles occurred.

In stationary practice, it was common usage to have a cup feeding oil into the cylinder or valves. This was satisfactory when saturated steam at low pressure was used, and the plant engineer did not care about the lubricating cost; but, with the use of higher pressures and temperatures, trouble arose and the lubricating engineer was called in to investigate. The average lubrication engineer had faith in the quality of oil used; therefore, his first investigation was to determine whether the type of lubricator used was the proper one. It was found that better results could be obtained by feeding minute quantities of oil with every revolution of the engine, thereby being sure that the oil was more or less atomized and reached all working and rubbing surfaces of the cylinders. This led to the development of the sight feed oil pump.

The point of application should be far enough away from the valves and cylinders to insure a complete atomization of the oil. This distance can best be deter-

mined by the design of the piping adjacent to the engine, for the presence of tees and elbows will often trap out the oil and cause it to flow along the sides of the pipes in a liquid state. The oil from the sight feed oil pump should be led to the desired point of application and should be injected into the middle of the steam line, where the velocity is the greatest. An atomizer should be provided at the end of the oil supply pipe, in the middle of the steam line, so that the oil is broken up into a spray and evenly distributed.

For cylinders using saturated steam, a compounded oil is almost a necessity, while for a cylinder using superheated steam, this composition is not always advisable; but when superheated steam is used in a compound engine, two grades of oil are advisable, namely, one for the high pressure and one for the low pressure. Only heavy bodied oils should be used when using superheated steam.

For many years it has been common knowledge among engineers that the best running properties of sliding surfaces are only developed when the machine has been in operation for a sufficient time to produce the hard so-called glazed surface. These glazed surfaces are a vitreous or amorphous layer on top of the metal and show that there is something beyond the necessity for the structure of bearing surfaces to consist of hard points embedded in a matrix of softer material, and that the mechanism of two surfaces in sliding contact is much more complex than is generally assumed.

In steam cylinders the friction coefficient increases slightly with the steam pressure. When the oil feed is scanty, the friction coefficient is large and very variable when the cylinder is under pressure. When the oil feed is shut off, the friction increases very rapidly, while under atmospheric pressure, when the lubricant is shut off the growth of friction is about six times as slow. When correct methods of applying the lubricant are used, as described in the foregoing paragraphs, it is possible to use a cylinder oil of a lower flash point than that of the temperature of the superheated steam, due to the fact that the flash points of oil when under steam pressure and in the absence of air are increased by a considerable figure and can be safely used in temperatures 100 deg. higher than that of their flash points in open air.

Carbon Deposits in the Cylinders

The finding of carbon deposits in the steam cylinders has generally led to the condemnation of the oil used as unsuitable. This is often far from being the case, and in most cases investigations have shown that the carbon deposits found were due to the excessive amounts of oil fed into the cylinders, for when the liquid lubricant comes in contact with the hot metal surface at the ends of the valve travel and in the counterbore of the cylinder, the oils suffer more or less decomposition and the formation of deposits occurs. Often when cylinders are examined for deposits, that which may be found may lead one to suppose carbonization of the oil has taken place. Many times such is not the case, for when the boilers are foaming and priming, deposits of scale will be carried over by the steam and deposited in the cylinders, and these deposits may quite easily be taken for oil carbonization products.

Steam Turbine Dangers

Notes on Operation, with Special Reference to Safety Devices, and Safe Operation

SERIOUS DAMAGE to steam turbines may arise from a number of causes, but the commonest immediate sources of trouble are (1) rubbing between the revolving and stationary members, and (2) overspeed. The turbine should be shut down as soon as the first sign of rubbing is perceived, and the difficulty should be remedied before the machine is again put in operation. In case of over-speed it is also imperative to shut down the turbine immediately; and if trouble of this kind occurs, the turbine mechanism ought to be capable of controlling the steam supply immediately, automatically and effectively.

Care of the Governor

Every turbine should have one main governing mechanism, competent to keep the machine running at designed speed under all conditions of load; and it should also have an emergency governor or control which will promptly shut down the turbine whenever the regular governing device does not function. To safeguard both of these mechanisms it is necessary to have the governing apparatus in proper working order, and it should be maintained in this condition by frequent examinations and tests. It is equally important to ascertain, at short intervals, if the emergency control and all the mechanism connected with it is in good operating condition. Special attention in this respect should be given after either the controlling-valve stems or the throttle-valve have been repacked. Accidents have been known to occur on account of using packing containing a considerable amount of rubber, which would swell and render the mechanism inoperative as soon as the packing boxes became heated.

Failure of the regular governing apparatus may result from ordinary wear, or it may be brought about in many other ways. If the load is suddenly thrown off, the governor is supposed to cut off the steam supply promptly and prevent racing. Not infrequently, however, the governor valve becomes worn so that it admits a considerable quantity of steam, even when it is supposed to be closed; and if the turbine is doing little or no work, it may speed up to the bursting-point in consequence. To guard against an accident of this kind the valve should be kept in first-class condition at all times.

The safety stop should not merely reduce the steam supply, as the ordinary governor does, but should cut it off completely and quickly, as soon as the speed reaches a certain definite limit. This limit may perhaps be 10 per cent in excess of the ordinary running speed, but the builder of the machine should be consulted on this point, and his counsel should be followed. It is spe-

cially important to see that the emergency stop is maintained in good condition at all times, because when a turbine starts to race there is usually a very small margin of time for action, if an accident is to be averted. The valve that is operated by the emergency stop should be of the quick-acting type, so that the steam will be shut off without a single second of needless delay. To test the emergency stop and insure that it is constantly in good working order, it is advisable to trip it every time the machine is shut down, instead of using the throttle-valve for this purpose, in the usual way.

Many turbines have valves in the exhaust lines, or discharge their steam into main headers having valves in them. The attendant sometimes forgets to open these valves, and when this occurs a dangerous condition is at once created, unless special provision is made for such a contingency. Every turbine that is installed in such a way that the exhaust line can be closed must be provided with a relief valve of sufficient capacity to discharge all the steam that can enter through the nozzles or other steam openings, without permitting the pressure inside the casing to rise higher than the limit that has been selected in advance as the limit of safety. In small machines the relief valve is commonly placed in the casing, so that it forms a part of the turbine itself; but in larger ones the relief valves are often installed separately, and connected with the casings by fittings or pipes of suitable size. The relief valve should be installed so that it cannot be shut off from the turbine by means of a stop-valve.

Governor Adjustment

If the governor valve of a small turbine is operated directly by the governor without a relay, it is very important that the valve should rest on its seat before the governor has reached the limit of its travel. Unless this adjustment is properly made and maintained, there is danger of overspeeding to the bursting point.

Adjustment of the setting of the governor valve should never be attempted except when absolutely necessary, and then only by an experienced man, who should make sure that the adjustment will not prevent the governor from closing the valve. The packing of the governor-valve stem should be attended to only when the turbine is shut down, and should be tested for sticking before the machine is put in service, and again after the packing has become heated up. Governor valves are likely to become leaky in time, and hence they should be carefully watched. The governor-valve stems are usually made small in diameter to prevent leakage, and they may become bent quite easily from knocks or shocks, so that the governor will not operate properly.

Dangers of Lack of Balance

Another prominent cause of trouble in connection with steam turbines is lack of balance of the rotating parts. This may arise in various ways. The rotor is supposed to be carefully balanced by the manufacturer of the turbine, but the balance may be disturbed by the making of repairs and in various other ways. Blades breaking off from the rotor will produce lack of balance to an extent corresponding to the number of blades that are lost; and masses of water entering the turbine from any cause may produce a very considerable lack of balance, momentarily, or may give the shaft a fixed set, resulting in permanent unbalance. The foundation for the turbine (especially if the machine is of large size) should be laid with extreme care, in order to insure absolute solidity.

In accelerating a turbine, the critical speed should be passed as quickly as possible, especially if a flexible shaft is used; but except as this speed is approached, the turbine should be accelerated slowly, because otherwise the rotor is likely to become distorted and cause the blades to come in contact with the casing and break. Whenever possible, the load should also be applied gradually after the turbine has been brought up to speed. Unless care is taken in these respects, troublesome vibrations may develop and persist for a long time. The present practice of nearly all steam-turbine makers, however, is to design their rotors so that the operating speeds are well below their critical speeds; and when it is known that this point has received attention by the builder, the turbine can be accelerated slowly throughout the entire range, with entire safety.

Vibration is not always caused by lack of balance in the turbine itself. It may also be due to defective balancing in the electrical part of the unit, or to poor alinement of the shafting. Correct alinement is of extreme importance. Flexible couplings are sometimes employed to prevent trouble due to misalinement, but, contrary to general opinion, they do not entirely obviate it, and particularly when they are used with small high-speed turbines. Misalinement may also be caused by improper piping installations in which the piping is arranged in such a manner that an excessive load is imposed on the turbine and forces it out of line.

Starting a Large Turbine

A large turbine should be started noncondensing, or with a low vacuum (not over 15 in.), in order that the large section of the rotor at the exhaust end may be properly warmed. At the outset, a little steam should be admitted to blow out the drain water, then the throttle should be opened up farther for a moment, until the rotor starts turning. The throttle should then be tightly closed, and almost immediately opened again—just enough to keep the rotor moving slowly. In this way the steam reaches all parts of the turbine, and the heating of the various sections or stages is approximately uniform; whereas, if steam is admitted in small quantities while the rotor is stationary, the steam tends to stay near the upper part of the turbine. The part exposed to the steam then becomes hotter than the other portions, and this causes distortion and strain, and lays the foundation for excessive vibration later on. In heating up a turbine, the drain pipes should be left open until full speed is attained. Small turbines may require little or no preliminary warming up.

A turbine running on a light load with the rotating parts rubbing against the stationary parts generates heat faster than the steam flow can carry it away. This will cause distortion of the parts affected and, if continued for some time, will seriously damage or even wreck the machine. Whenever rubbing is noticed, immediate steps should be taken to remedy it by finding the cause and removing it. Rubbing must never be permitted to go on, under any circumstances.

A turbine that is out of service for some time, or that is used intermittently, is subject to corrosion from throttle leakage. The junctions of the blades with the disk are especially susceptible. When steam leaks in through the throttle of a large turbine it is also likely to cause distortion of the spindle, on account of the uneven expansion that occurs when the steam blows in on one side. The use of brass lining strips helps to reduce corrosion from the throttle leakage, but the only right thing to do is to see that no leakage occurs. The throttle should receive careful attention and should be kept in first-class condition at all times. In the steam line of every large turbine there should be two valves with a good-sized "leak-off" between them. By adopting an arrangement of this kind and closing both valves whenever the turbine is shut down, it is an easy matter to prevent damage from leakage.

Water is always likely to make serious trouble in a turbine, from whatever source it comes. It is likely to back up from the condenser unless special provision is made to prevent action of this kind. The impact due to a mass of water striking against the blades of a turbine may be very considerable if the machine is running at full speed, and it is quite likely to strip the blades or lead to vibration and other serious results. This source of trouble is pretty generally recognized, and turbines are usually guarded satisfactorily against flooding from the condenser.

Water is sometimes carried from the boilers over into the turbine through the steam supply line, and when this occurs the water is likely to do serious damage. In these days of high superheating, the damage to a turbine from the entrance of water through the steam main is likely to be materially greater than in the old days of saturated steam or slight superheat, because the temperature changes that are produced by the water in the turbine are far more severe, and the distortions of the revolving and stationary elements may be so bad that serious rubbing will take place. (Many engineers are of the opinion that superheated steam can never carry moisture, and hence that there can be no trouble from water in turbines using superheated steam. This is not the case, however.) If a turbine is loaded too suddenly, after it has come to speed, the governor will open quickly and admit a correspondingly large quantity of steam to take care of the increase in the work to be done; and when this occurs, slugs of water are likely to be carried over by the steam.

Turbine accidents have occurred from leaving tools, fittings, or other objects inside the machine when closing it up after making repairs, and the possibility of this should be borne in mind whenever turbines are opened up for repairs or inspection.

It is extremely important in the operation of a turbine to apply constant lubrication to the bearings, and to use oil of the best quality. An alarm or some other device might be used to advantage to give notice in case the supply in the oiling system falls below the point of safety. If a bearing becomes unduly heated, the engineer in charge should immediately increase the supply of oil, and if this is not followed by marked improvement, the turbine should be stopped and the cause of the trouble investigated. The oil wells should be cleaned out before starting the turbine, and care should be taken to see that they are kept clean. If sediment accumulates in the oil wells, it is also likely to collect in the oil grooves, where it may carbonize and eventually entirely fill the grooves.

Inspection

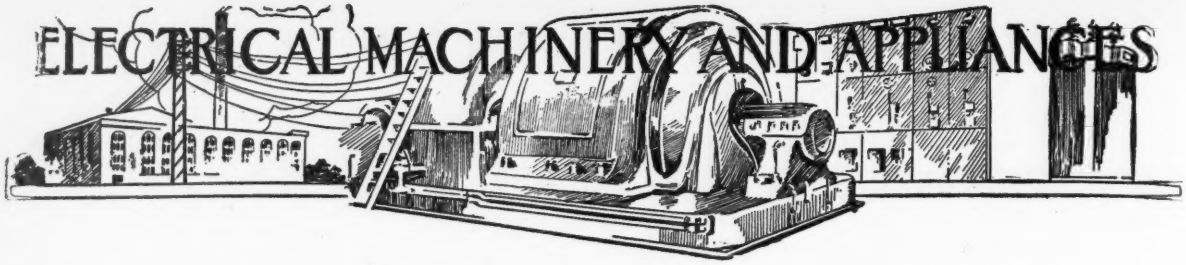
When a turbine is opened up for inspection or repairs, the work should be supervised by a skilled man sent by the manufacturer of the turbine, until the operating engineer has become thoroughly familiar with it; and when the machine is large or complicated, the manufacturer should always be consulted before it is opened up. In removing and handling the rotor special care should be taken to avoid injury to the blades and other delicate parts. At the time of such inspection, the oiling system should be completely cleaned out and filled with new oil. After the parts have been assembled again, and before admitting steam to the machine, the rotor should be turned over by hand, to see that it does not bind nor meet with serious resistance to rotation. Inspections of the kind indicated should be made at least once a year, and every part of the turbine should be examined at such times for defects of every kind.

A turbine designed to run noncondensing should not be operated condensing except after consultation with somebody qualified to express an intelligent opinion as to the practicability of the change; and a turbine designed for a constant pressure should not be used on what is called the "mixed pressure" system, unless similar care has been taken to ascertain that such change is advisable as well as satisfactory, and that suitable steps are taken to prevent a runaway——The Travelers Standard.

Why Unbalanced Current?

By J. M. Burke

"WHAT is the reason that the current, the voltage and the watts power are not the same on all of the three phases of a 3-phase induction motor?" is a question asked often by the practical man. The explanation in the average case is that the voltages impressed on each of the three phases of the motor are not equal. Under ideal conditions the voltage, the current, and the watts power should, respectively, be equal on each of the three phases of a 3-phase induction motor. There are a number of possible reasons for the "unbalancing." It may be that the generator producing the energy develops unbalanced voltages; that is, the electromotive forces impressed by each of its phases on the line wires may not be the same. Again, assuming that the generator voltages are balanced, which they probably are, it may be that the resistance or reactance of one of the conductors of the 3-phase transmission line is materially greater than that of the other two. Also, the transforming arrangement (transformers), if such is employed, may produce an unbalanced voltage. If a motor is giving satisfactory service and does not heat unduly, it is not probable that the unbalancing is of great practical consequence. If the unbalancing is causing trouble, it is, probably, due to one of the causes above suggested.



Alternating Current Regulators---V

DESCRIPTION OF REGULATOR, THE MAIN CONTROL MAGNET OF WHICH IS ENERGIZED BY ALTERNATING CURRENT FROM SYSTEM BEING REGULATED. BY V. E. JOHNSON

ANOTHER make of regulator employs the same fundamental principle of regulation as the type described in the Nov. 15 issue. It also uses a vibrating switch shunting the exciter rheostat, and having a variable vibration ratio. This switch takes the form of a differentially wound relay, having across its contacts a condenser and controlled by main contacts which automatically adjust the vibration ratio to maintain proper voltage.

In Fig. 18 is shown an elementary sketch of this regulator; the parts may be classified as A, consisting of the main and relay contacts, the rheostat shunting

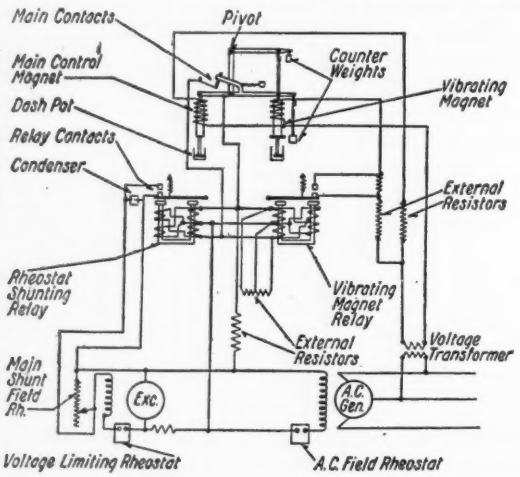


FIG. 18. ELEMENTARY SKETCH OF ANOTHER MAKE OF TIRRILL REGULATOR

relay and its spring and the condenser; B, consisting of the vibrating magnet and its plunger, the dashpot, springs, main contacts and the vibrating magnet relay; C, consisting of the main contact magnet, the dashpot, core of main control magnet, and the system of springs and lever which also come under B; D consists of parts to be described later.

There are no d. c. coils in either B or C; ratio of vibration is determined by the interaction of these two parts, and is not affected directly by exciter voltage. The only direct current parts are the relays—which are operated from some source of d. c.—usually the exciter busses.

Vibrating magnet (part B) is really the least of the apparatus.

Let us assume that the main control magnet has its core blocked. There is, however, enough room between the core and coil to permit a lateral movement. This, then, is equivalent to substituting for the magnet core a lever pivoted at the lower end, leaving the elementary arrangement shown in Fig. 19.

The core is supported at all times by spring tension and the upward magnetic pull of the coil surrounding it. When contacts (A) and (B) are open this magnetic pull is zero, and the plunger drops. Dropping of the core closes the contacts, thus energizing the coil and producing an upward magnetic pull which if

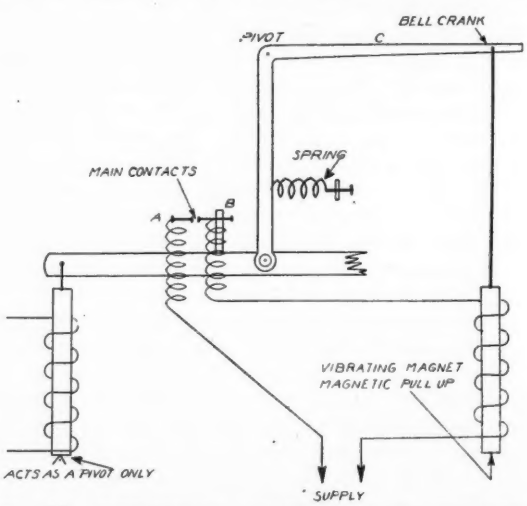


FIG. 19. ELEMENTARY ARRANGEMENT OF OPERATING MECHANISM

sufficiently strong will open contacts (A) and (B) through the medium of bell crank (C), reducing the magnetism to zero again. If the weight of the plunger is less than the combined spring pull and average upward pull the main contacts would remain open. This could in this case only happen when the spring pull was greater than the plunger weight—as there would be no upward magnetic pull with the contacts open. If the weight of the plunger is greater than the average upward magnetic pull and the spring pull, the main contacts would stay permanently closed.

The magnetic pull is dependent on and proportional to the voltage impressed across the magnet terminals, and to the ratio of closed time to open time. The

downward pull of gravity on the plunger is constant as is the spring pull upward. The only variables then are the impressed voltage and the ratio of "closed" to "open" time. Therefore an increase of voltage must result in a decrease of the "closed to open" ratio and vice versa.

Similarly, increasing the tension of the spring would decrease the ratio of "closed" to "open" because a lower average magnetic pull would suffice to keep the magnet in vibration.

Looking at the situation from a different viewpoint, moving contact (A) to the right would necessitate an increased average magnetic pull in order to maintain vibration, because in a sense this is equivalent to weakening the spring tension.

In Fig. 20 is shown the same sketch as that of Fig. 19, the only difference being that in this case the contacts upon opening do not interrupt the current entirely, but simply introduce into it a resistance. Under these

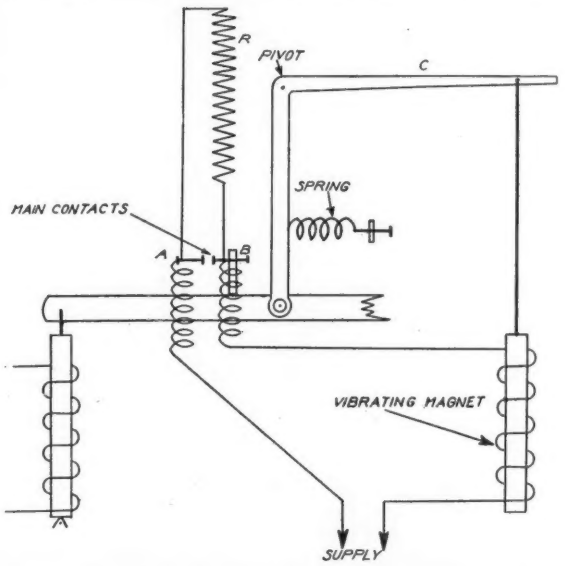


FIG. 20. ELEMENTARY ARRANGEMENT OF OPERATING MECHANISM WITH RESISTANCE ARM CONTACTS A AND B

conditions, vibration will continue (as before) only when average upward pull plus spring pull equals weight of plunger, but in this case the average upward pull consists of two parts—"pull open" and "pull closed." By increasing the resistance across the main contacts, "pull open" is decreased until this resistance becomes that of an open circuit "pull open" or zero. Thus we see that there is no fundamental difference between the two arrangements. There is, however, a distinct advantage in the scheme of Fig. 20 because under these conditions a small change in voltage produces a large change in vibration ratio.

If, now, by means of a rheostat shunting relay in circuit, the vibrating magnet is made to open and close intermittently a shunt across an exciter rheostat, controlling the voltage of the alternator to which the vibrating magnet is connected, the results would be as follows:

(1) If the a. c. voltage were just sufficient to produce the vibration ratio required by its exciter for the maintenance of this voltage the ratio of closed to open would be constant.

(2) If the a. c. voltage dropped below this value the decreased average upward pull in the vibrating magnet core would result in a greater ratio of time closed to time open, which in turn would increase the a. c. voltage.

(3) If the a. c. voltage increased above this value the increased average upward pull on the vibrating magnet core would result in a lower ratio of time closed to time open and would in turn lower the a. c. voltage.

(4) Tightening the spring would decrease the a. c. voltage, and vice versa.

(5) Moving contact (A) to the right would raise

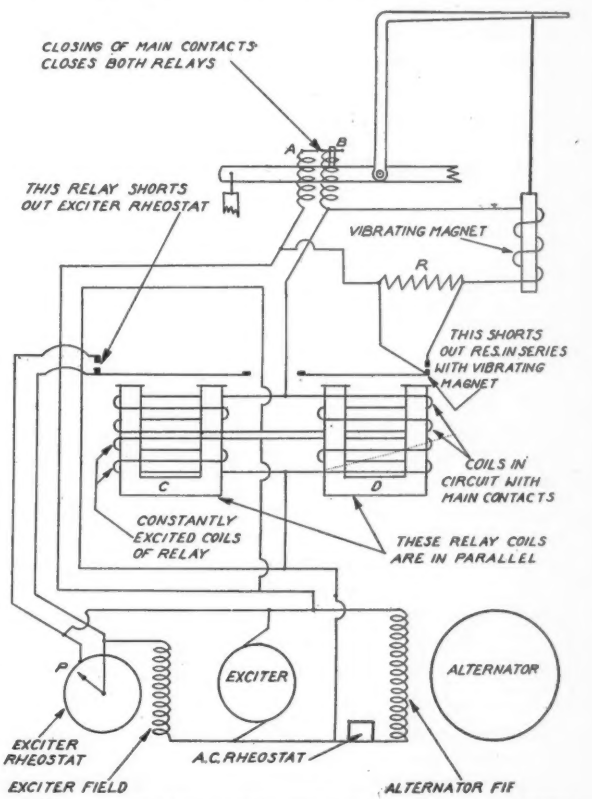


FIG. 21. REGULATOR CONSISTING OF VIBRATING MAGNET AND ITS RHEOSTAT SHUNTING RELAY

the exciter and generator voltage; moving it to the left would decrease these voltages.

(6) The frequency of vibration is independent of exciter design and depends only on regulator design.

For any position of the "screw rheostat handle" then the tendency is to maintain a certain definite voltage. Any change of load producing a change in voltage would result in a change of vibration ratio which would tend to correct or cancel the voltage error introduced.

In Fig. 21 is shown a regulator consisting only of the vibrating magnet and its rheostat shunting relay. Instead of having the resistance in series with the vibrating magnet (upon which depends the "open contact" magnetic pull) short-circuited directly by the main contacts a second relay, the vibrating magnet is used. Assume that the generator is to supply 110 v. Also assume that this voltage applied across the vibrat-

ing magnet produces a ratio of C ÷ O = closed ÷ open. Before relay (C) can be connected across the terminals of the exciter rheostat the exciter must be so adjusted that a vibration ratio of C/O will produce just 110 v. a. c.—in order that the various forces may be in equilibrium at this point. If upon connecting the relay into the rheostat circuit the voltage is not held correct, the obvious remedy will be to change the ratio C/O by adjusting the screw or changing the exciter constant.

Having then reached this condition of equilibrium —and at a point where C/O = K where K is any constant the following facts may be noted:

(a) With the voltage at 110 v. the vibration ratio C/O = K cannot change—inasmuch as the spring tension and weight of the plunger are constant.

(b) This ratio C/O = K maintains a constant effective exciter field circuit resistance. This field resistance consists of two parts: the field coils themselves, and the external portions of which one part, the rheostat, is intermittently short-circuited.

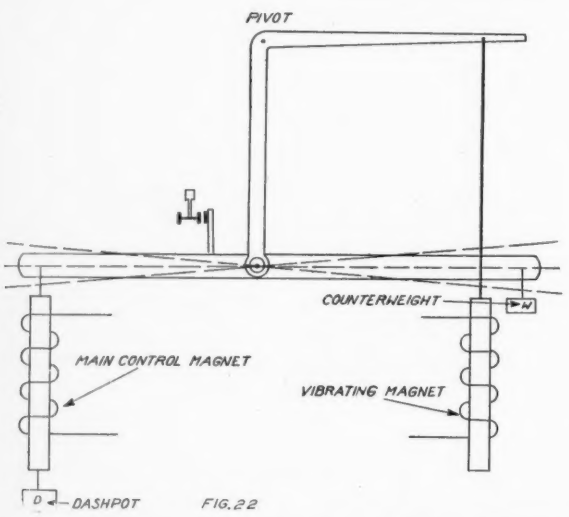


FIG. 22. MAGNET LEVERS AND A. C. MAIN CONTROL MAGNET

(c) Maintaining the exciter field circuit resistance constant as above maintains the exciter voltage and the generator excitation constant, as the generator rheostat is not to be moved.

(d) Constant generator excitation does not, however, mean constant generator voltage, because changing loads demand correspondingly different field strengths.

(e) Therefore a change in load on the generator can obtain for the generator field increased excitation only by a change of C/O = K, which in turn can only be obtained by a change of the voltage impressed across vibrating magnet terminals.

From this, it follows that a regulator such as that of Fig. 21 cannot give straight line regulation—the voltage of the a. c. busses must drop off in order to increase the field strength. No matter how the parts involved are adjusted perfect regulation cannot be obtained. This is analogous to an engine governor, which can admit more steam to the engine cylinder only by responding to a drop in speed of the engine. If the engine did not change its speed, the governor would not act; in other words, in this case, too, making straight line speed regulation impossible.

With the above conditions in mind, consider the arrangement shown in Fig. 18, in which the system has been altered by the addition of a second a. c. magnet known as the main control magnet, a so-called straight-line magnet. For a fuller understanding of this a sketch of the magnet levers and a. c. main control magnet is shown in Fig. 22. The system consisting of magnet and counterweights is balanced for a definite magnetic pull —and under this condition of balance the system will remain at rest in any position as shown by the dotted lines. A slight unbalance in either direction will cause the levers at once to seek one of the extreme positions. This is made clearer by the assumption made in Fig. 23 when a definite weight is substituted for the magnetic pull in Fig. 22. It is obvious that if weight (A) be increased or decreased, lever (C) will at once go to one of its extreme positions.

In Fig. 22, dashpot prevents the lever from instantly going to the limiting position—and introduces a predetermined delay. If given sufficient time, however, even the slightest unbalance would cause a complete movement.

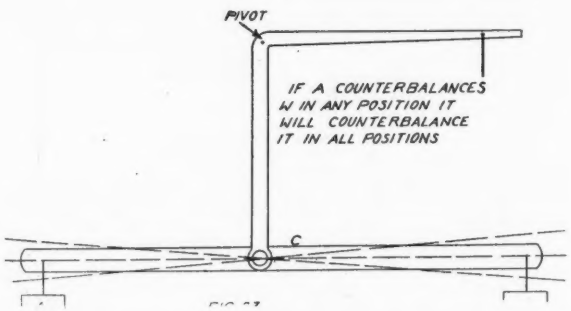


FIG. 23. SHOWING USE OF DEFINITE WEIGHT IN PLACE OF MAGNETS ILLUSTRATED IN FIG. 22

Referring now to Fig. 22 let us assume the a. c. voltage to be regulated for is 110 v. At this voltage the lever can be placed in any position within the limits of its design—and it will remain there. On the other hand, if the voltage drops to 109 the lever will, if left to its own control, go down to the limit; an increase to 111 will raise the lever to its upper limit. The time necessary for this action depends on the amount of unbalance and the amount of damping by the dashpot.

If the voltage remains at 110 v. the ratio of vibration of the vibrating magnet remains at C/O = K as discussed. If now a load is thrown on the generator followed by a drop of voltage, the ratio C/O is increased, but the vibrating magnet cannot return the voltage fully to normal. At the same time that the voltage dropping increases C/O it also unbalances the system of forces between the main control core and its counterweight. The main plunger begins to sink downward as rapidly as the dashpot permits, and in so doing it throws the moving contact nearer the stationary contact, the effect being exactly the same as turning the "screw" forward. This increases the ratio C/O above the value established in the vibrating magnet system by the drop alone and starts to increase the voltage. The voltage continues to rise and the main plunger to drop until 110 v. is reached,

at which point the main plunger stops. The voltage must be held exactly at this point, for the very slightest change starts the main plunger moving and immediately re-establishes a balance. The plunger is at its upper position for conditions demanding the minimum excitation, and occupies successively lower positions for conditions demanding increasing amounts of excitation.

In actual commercial use, the vibrating magnet alone compensates for ¾ of the error in voltage, while the main control system produces the remaining ¼ of the correction.

The compensating devices consist either of compensating windings with adjustable taps on the main control and vibrating magnet spools or else of external line drop compensators connected on the circuit of the potential

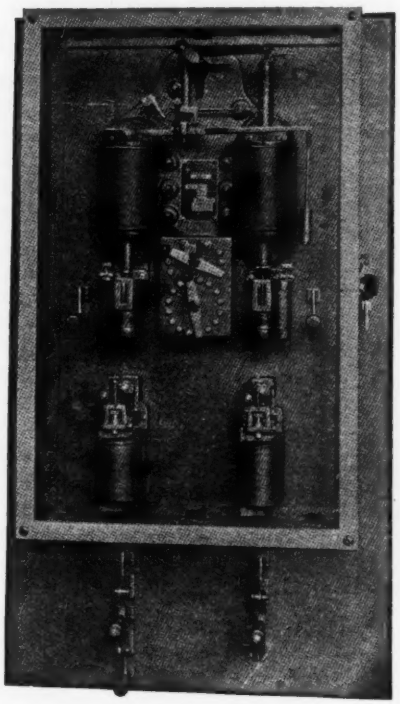


FIG. 24. A SINGLE-RELAY REGULATOR

transformer supplying the vibrating and main magnets.

By eliminating d. c. from the control of this type of regulator, it is possible to apply it to systems requiring extremely broad ranges of excitation. This is of particular advantage when controlling synchronous condensers, on which conditions sometimes require operation under "no field" excitation. By providing a separate source of direct current for relay operation a regulator of this kind can maintain perfect voltage through a exciter voltage ranging from residual to full field. With a d. c. magnet control involved it is difficult to go much beyond a 2 to 1 ratio of exciter voltage because of the difficulty of obtaining satisfactory accuracy beyond these limits.

The number of relays can be increased indefinitely to meet the demands of systems of any size. This is done by interposing between the main contacts and the rheostat shunting relays—one or more master relays.

In commercial form the regulator resembles very closely the schematic form discussed. Reversing switches and other refinement for convenience in manipulation are of course added.

Effect of Rheostat Manipulation

If the a. c. generators are in parallel and the exciters are also in parallel, any adjustment of the generator rheostats changes the amount of wattless current flowing between them. This follows from the fact that the changing of one field, for example, tends to change the bus voltage, and by so doing changes the exciter voltage in the opposite direction.

With the generators in parallel and the exciters not in parallel, the wattless current could be controlled either by adjusting the generator rheostats or by means of the equalizing rheostats in the exciter field circuits.

With the generators operating parallel or non-parallel, but with the exciters in parallel, the loads between the latter must be divided by means of the equalizing rheostats.

With an equalizer rheostat provided in each exciter circuit, and the exciter operating non-parallel, complete regulation could in the majority of cases be secured with the generator rheostat entirely omitted. This would mean considerable saving in space and first cost. Such a system would likely, however, require a greater than 2 to 1 ratio of excitation, in which case it would hardly be practical to use a d. c. controlled regulator. On the a. c. controlled apparatus a separate source of direct current would be necessary to actuate the relays.

With one generator operating alone, turning the generator rheostat "in" increases the exciter voltage, while turning it "out" has the opposite effect. In general, the rheostat should for economy's sake be turned all "out," as considerable energy is wasted in it if this is not done. If, however, turning the main rheostat all "out" drops the exciter voltage below 70 (on a 125-v. regulator) unsatisfactory regulation will result; below this value, the relays are sluggish on either type while on the d. c. controlled regulator, the d. c. magnet begins to be inaccurate.

U. S. Civil Service Commission announces an examination, Dec. 30, for mechanical draftsman, to fill vacancies occurring in the Patent Office, Department of the Interior, Washington, D. C., and in positions requiring similar qualifications, at $1000 a year, or higher or lower entrance salaries. Both men and women, if qualified may enter this examination, but appointing officers have the legal right to specify the sex desired in requesting certification of eligibles. Applicants must have a complete common-school education, and have had at least 1 yr. of experience in drafting, either in office, drafting class, or high-school course, and must have reached their eighteenth birthday on the date of the examination. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

According to the Council of National Defense, it is announced that Charles Bingelli, an engineer of Berne, Switzerland, has invented process for soldering aluminum. Heretofore aluminum has defied welding.

Electric Propelling Machinery of the U. S. S. Tennessee

ONE OF THE LARGEST BATTLESHIPS AFLOAT; MAXIMUM POWER 33,500 HP.; MAXIMUM SPEED OVER 21 KNOTS. BY WILLIAM H. EASTON

WHEN the United States Battleship Tennessee was launched at the Brooklyn Navy Yard one of the most formidable machines of its kind in existence was set in motion. The speed of the Tennessee will permit her to equal any vessel of her class. In addition to her speed, it is stated that she will be able to shoot harder and stand more punishment than any other vessel afloat. Her overall length is 624 ft; beam 97 ft; draught 31 ft, and full load displacement 33,000 tons. She will be propelled by electricity and each of her four propellers will be driven by its own motor and current will be supplied by two turbine-driven generators. Her maximum power will be 33,500 hp. and her maximum speed, over 21 knots.

With geared turbines, there is little leeway in the location of the engine room. With electric drive, however, the turbines and propellers are entirely separate mechanically and the former can be placed in almost any desired location. In fact, owing to the freedom of locating bulk heads, it is possible to make an electrically operated battleship practically torpedo proof. The motors can be placed well aft, so that the length of the propeller shafts can be reduced to a minimum; and the turbines can be so located with reference to the boilers and condensers that steam, oil, exhaust, and other important pipe lines can be made as straight and short as possible.

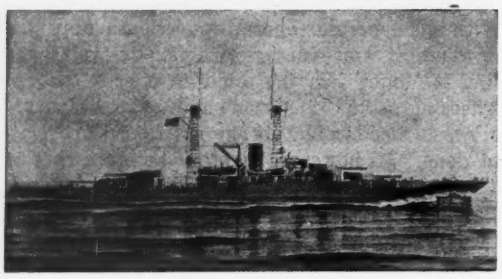


FIG. 1. ELECTRICALLY DRIVEN BATTLESHIP TENNESSEE

THE TURBINES

THE TURBINES of the U. S. S. Tennessee are of the single-cylinder, semi-double flow, impulse-reaction type. The high-pressure steam first passes through a two-row impulse wheel in each turbine and then through a section blading. It then divides into two equal parts and each part passes through a low-pressure reaction section into the condensers.

The speed of the turbines can be varied through a range of from 1500 to 2270 r.p.m., by means of manually-controlled hydraulically operated governors. The movement of a control handle varies the pressure in an oil system and this in turn varies the loading of the governor, and causes a change in speed. This system is superior to one in which the control handle and governor are mechanically connected because there are no rods or shafts to jam where they pass through the bulk heads. A unique feature of this system is that the oil pressure is caused to pulsate thus keeping the entire mechanism slightly in motion. This prevents sticking of the parts and adds greatly to the sensitiveness of the control, which is of great importance when ships are steaming in formation.

The speed of the turbines, as determined by the setting of the governor, remains practically constant regardless of the load and hence the propellers do not race when they leave the water in rough weather. Automatic stops are also provided, which cut off the steam in case the speed of the turbines exceeds a safe limit.

THE GENERATORS

THE GENERATORS, which are directly connected to the turbines, are two-pole machines and supply the motors with 3-phase, 3400-v. alternating current at frequencies ranging from 25 to 38 cycles, depending on the turbine speed. They are excited from the direct-current power supply of the ship and each can develop 15,000 kv.a. at the maximum speed of the turbine.

The generator coils are carefully insulated so as to prevent injury from high temperature, moisture, and accumulations of salt. They are kept cool by air, which is forced through the ventilating ducts by fans mounted on the rotor shafts.

THE MOTORS

THE FOUR MOTORS are of the induction type. They are directly connected to the propellers and each can develop a maximum of 8375 hp. continuously. To provide a sufficiently wide speed range, each has two windings, one of 24 poles and the other of 36 poles. The same result could have been obtained by the use of a single winding, but this would have involved greater complication in the connections and would have restricted the design in other ways. The 24-pole winding is connected to slip-rings on the rotor shaft, while the 36-pole winding has short-circuiting connections and is equivalent to a squirrel-cage arrangement. Both windings are used for running, but only the 24-pole for starting and reversing, resistance being inserted in series with it during these operations.

The insulation of the motor is similar to that of the generators and ventilation is provided by means of two motor-driven fans mounted on top of each motor.

SPEED CONTROL

THE METHOD of controlling the speed of the motors can be readily understood by considering that the 36-pole winding is equivalent to a gear of an 18 to 1 ratio between the turbines and the propeller, while the 24-pole winding is equivalent to a gear of a 12 to 1 ratio. Hence when the 36-pole winding is used, the motor-speed will vary from 83 to 126 r.p.m. when the turbine speed is varied through its range of 1500 to 2270 r.p.m. and with the 24-pole winding, the motor speed ranges from 126 to 186 r.p.m.

To control the speed of the ship, three different combinations are employed:

1. From 9 to 15 knots per hr., the motors are operated on the 24-pole windings by means of one turbo-generator.

2. From 15 to 17 knots per hr,. the motors are operated on the 36-pole windings and all four are driven by one turbo-generator.

3. From 17 to 21 knots per hr., the motors are operated on the 24-pole windings by means of both turbo-generators.

To reverse, two phases at each motor are transposed without changing the direction of rotation of the turbo-generator.

Steam Consumption

The use of one turbo-generator for the lower speeds assists in maintaining good operating economy by keeping the load on the unit close to its rated capacity except at the very slowest speeds. The steam consumption per shaft horsepower-hour, including that required for excitation, condenser operation, and motor ventilation, is as follows:

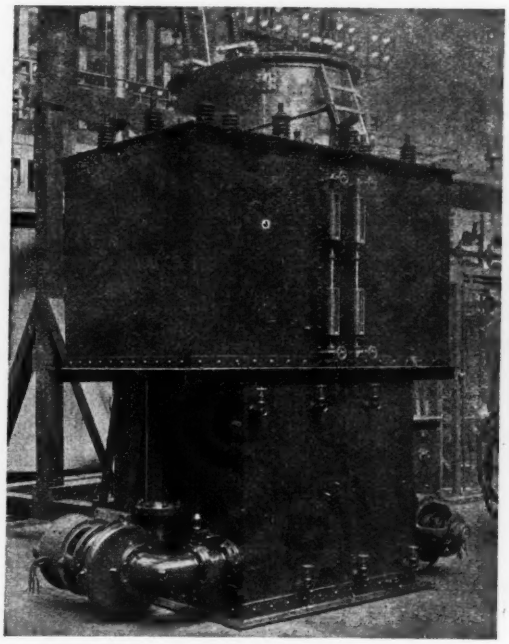


FIG. 2. LIQUID RHEOSTAT FOR CONTROL OF MAIN DRIVE MOTORS

Speed in Knots	Motor-Poles	No. Turbo Units	Lb. of Steam
9	36	1	16
15	36	1	12
15	24	1	13
17	24	1	13
17	24	2	12.4
19½	24	2	11.7
21	24	2	11.9

Control System

Switching apparatus for controlling and distributing the power to the motor, for regulating the main turbines, and for controlling the excitation of the generators, is located in a control room, where the operator has directly in front of him everything necessary for the operation of the equipment. Full advantage has been taken of the great facility with which electric current can be measured, inasmuch as the data thus obtained greatly assists in the operation of the ship.

The rheostats used for starting and reversing the propeller motors are of the automatic liquid type, in which the resistance is varied by means of a pump, which alters the level of a liquid in which fixed electrodes are immersed. This type of rheostat, though not as yet extensively used by the Navy, has become very popular in industrial service because of its simplicity, compactness and reliability.

The cables connecting the generators and motors are of great importance because the operation of the ship depends upon their reliability. In order to insure the best possible type of construction, a Committee of the American Institute of Electrical Engineers assisted the Navy Department in preparing the specifications for these cables. They are of the three-core type, and are laid in a number of parallel circuits so that the failure of any single cable will not seriously interfere with the operation of the ship.

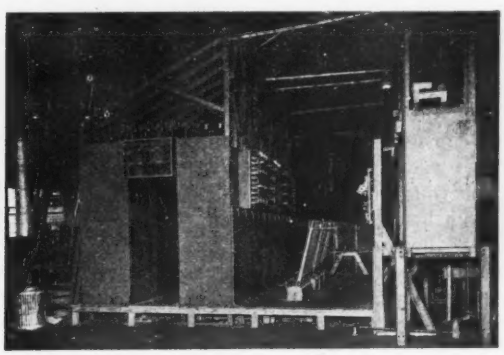


FIG. 3. SWITCHING APPARATUS SHOWING CONTROL LEVERS

Auxiliaries

The main circulating pumps are of the centrifugal type and are operated by 235-hp. motors. Their speed may be varied to suit conditions so that the power consumption can be reduced with the speed of the ship. Air ejectors, which are novel on this class of ship, maintain a high vacuum in the condensers. The condensate is handled by motor driven vertical centrifugal pumps. Thus, all the main engine room auxiliaries are rotary and are motor driven, which it is believed, will insure a higher degree of reliability than the use of some of the older forms of equipment.

An editorial in a recent number of the New York Times says, in referring to the International Trade Conference recently held at Atlantic City: "All our visitors wanted both to buy and to borrow. The quantities were unheard of. France is asking for $145,000,000 of foodstuffs alone, 1,000,000 tons of wheat being one item. Italy wants $800,000,000 of everything, coal in particular. Belgium would like $100,000,000 to go on with."

Fired at Fifty?

MEN ARE NOT FIRED ON ACCOUNT OF AGE, BUT FOR LACK OF ABILITY TO "DELIVER THE GOODS." BY FRANK FARRINGTON

WILL YOU be fired for old age or inefficiency when you pass the half century mark, or will you be regarded as one of the most valuable men on the job because of your experience and judgment and steady habits?

The young fellow in the twenties thinks he hasn't anything to do yet with what is going to happen at fifty. That age looks a long way ahead. Let fifty take care of itself. Thirty does not give fifty very much more thought, but the man in the forties begins to take notice. He sees that he is going to be fifty and that it will not be long to wait either.

One reason why the younger men don't concern themselves too much about fifty is that they have the idea that by the time one is that old, he has just naturally been promoted until he has an executive job and a roll top desk and maybe a stenographer.

Most of us who think that at fifty we will be executives are going to be disappointed. This has to be because there are not executive positions to go around and also because the larger proportion of us will not work hard enough or study our business or the technical side of our trade hard enough.

You can be an executive at fifty. You *can* be one of the men whose work is done at a roll top desk, but whether you will be or not is dependent upon yourself and upon how hard you work to that end.

At all events, you are not going to be fired at fifty or sixty or any other age just because you reach that age. If you are fired, it will be because you are not delivering the goods, and that may happen at any age.

This much is certain: If you are going to be a good man after middle age, you must prepare for it earlier. If you expect to make good at fifty, you must take such care of yourself that you will be physically fit in your later years. The man who abuses his body while he is young reduces his ability at the time, reduces his chance of advancing, perhaps eliminates his fiftieth birthday altogether.

If you are not physically competent at fifty to do good work, of course you will not be valuable to anybody. See that any lack of health at fifty is at least not due to carelessness while on your way to middle age. We do not expect a man of fifty to show the pep of a twenty-year-old; but unless you can do what a fifty-year-old may reasonably be expected to do, your services will not be required.

Everything else being equal, the employer would prefer a young man to a middle-aged man; but everything else is not equal. The young man has the strength and endurance, but he has not the knowledge or experience to enable him to do as good work. He can work harder than an older man, but he does not always work as hard as he can. The experts in any branch of work are among the men of experience, many of them fifty or older.

The older man is more settled in his ways. He is not all the while looking for a chance to make a change of job. He has a family and friends where he is and it is worth something to him to remain. The boss knows where to find this type of man and there is not the fear every pay day that he may decide to quit.

The man of fifty has found that although farthest fields always look greenest, they are never quite as green as they look. A little more money somewhere else where the cost of living is greater (to say nothing of the cost of changing) does not tempt the wise old chap who is well off where he is.

The younger men are more ambitious. They have visions of hitting the high spots in the trade. They ought to feel that way. Every young man ought to be trying to become something bigger and better, but it makes a poor working force if all are keeping only one eye on the job while the other is looking for something that offers a little more wages.

I don't mean that a man of fifty ought to lay aside ambition. We all ought to keep our ambitions to the end; but by the time a man reaches fifty, he has settled into his job and he knows what he can do and about how far he is likely to go.

If you make good use of your opportunities to learn more and more about your trade and to make friends in your field of work, your years will be a help, not a handicap when you come to fifty.

Many a boss gets tired of taking on green men and training them and having them jump to some other job that pays them a few dollars more, perhaps leaving opportunities for advancement that they will not find elsewhere. A manager, however, cannot get all his help by hiring it away from other plants or other jobs by paying more money; that sort of thing might result in a boss getting together a good force, but he would be paying them so much money that he might better sell out his business.

It is not to be expected that a man at any age is going to turn down opportunities for advancement which involve changing employers, but there is something to consider besides the mere immediate raise in pay. The employe who stays where the pay is good and the opportunity for advancement is good is farther along at fifty than the man who is constantly jumping to get a little advance and who finally gets a reputation for being unsettled and unsteady and finds his pay going down instead of up.

The uncertain, jumpy kind of a force when it comprises the more unsteady element of younger men makes the older men look pretty good to the boss who doesn't want to be worrying all the time about whether he will have a force tomorrow or not.

Of course, an elderly man looking for a job may find it hard to get one; but that is going to be due to the way he has shifted about until middle age finds him without any influence or friends anywhere and with nobody feeling sure of his value.

The habits of work and conduct that you know will enable you to make good in your later years must be cultivated now. You cannot be a high class workman as an elderly man if you are a careless, slipshod workman when young. It doesn't work out that way.

Employers know that a man's habits do not change

much after he is fifty. If he has wrong methods when he is young, he may be kept on the job because he *is* young and the boss knows that he can be taught better ways. We hire young men because of what they are going to learn and the ability they are going to develop. But at fifty you will have your job because of what you learned when young.

At any age, you ought to be trying to learn all the improved ways of doing your work. You ought to be open-minded enough to be willing to admit, even at fifty, that your way may be wrong; just because you have always done it a certain way is no sign that way is right. There are new methods of all sorts of work constantly coming to the front and it's a wise worker who has his eye open for such.

The trouble with the fifty-year-old is often that he thinks it is too late for him to learn anything. He says, "Well, it's too late. I've always done it so and so and you can't teach an old dog new tricks." But you can teach an old dog new tricks if he is willing to try to learn. If you cannot learn new methods after fifty, it is your own fault for not being willing to try.

Only an old fogy will refuse to keep up with the times in his line of work. There are young men who think they know it all and they are hard to handle to advantage, but their pig-headedness is nothing when compared with that of the older men. But don't be pig-headed at any age. Don't think you know it all; you don't; you can learn every day something about your work.

Fit yourself physically now for continuing your work as long as you live. You will enjoy life a good deal more to wear out than to rust out. See that you are constantly considering how to have good health because whether you continue to work or whether you retire, life will not be very valuable if you do not have health. You can make yourself so good a workman that you will be wanted on the job as long as you work. It is all up to you. Father Time cannot put much over on you without your consent.

Industrial Health Hazards*

PURELY INDUSTRIAL HAZARDS SMALL AS COMPARED TO THOSE DUE TO DISEASE OR NEGLECT. SUGGESTED REMEDIES. BY DR. CHARLES A. LAUFFER

MODERN industrial developments, collecting vast multitudes of men and women in industrial establishments, bring to the forefront the problem of health hazards. The vast exodus from rural to urban life during the past generation, forcing into indoor occupation individuals whose ancestors for generations lived out of doors, has further emphasized the problem of health hazards.

A study of these problems is vital to the employe; health, long life and happiness are involved. It is fundamental to the employer; increased production; diminished labor turnover; contented ranks of healthy, happy, veteran employes—all tending to increased profits.

INDUSTRIAL HEALTH HAZARDS OF EMPLOYES

THE INDUSTRIAL health hazards of the employes may be grouped as arising from:

1. Poisons, dusts, fumes, gases.
2. Heat, humidity, ventilation.
3. Lighting.
4. Crowding.
5. Fire peril.
6. Association with diseased employes.

The most used poison is lead. Not every employe who handles a paint brush, however, gets lead colic; some paints are innocent of lead, yet employes, who have never touched lead, will bring in diagnoses of "lead poisoning," merely because an attending physician knows they are painters. Lead storage in the tissues may ensue when lead is carelessly handled, yet lead poisoning is practically unknown in large plants handling hundreds of tons of lead every year. The extent of industrial lead poisoning, we know, is much less than some reports would have us believe. Employes who cannot be taught to wash their hands before eating and who never clean their finger nails, nor care for their teeth, are particularly liable to lead poisoning. Individuals who have once developed toxic lead symptoms should be given other employment, as the poison is accumulative, and is never entirely eliminated, hence relapses readily occur, making permanent transfers to other lines of work necessary.

Persons having a tendency to eczema, or furunculosis, may develop a skin rash from the solvents employed in removing varnish, shellac, and various insulation dope. Cutting oils, recovered by centrifuge methods, provoke skin infections; forced filtration through successive layers of filter paper removes minute metallic spicules, and filters out bacterial flora that affect the skin. Cutting compounds are often culture media for pathogenic bacteria, and may require sterilization—by heat, chemical and filtration methods. Minute burns from flying hot chips; abrasions by metallic spicules in dirty cotton waste—used in rubbing the hands and arms—rough scrub-brushes or caustic soaps, may provoke such dermatitis. Every industry has its own problem, or succession of problems, in this line. When 150 employes are subjected to the identical exposure, and only three develop industrial dermatoses, the factor of personal susceptibility is suggested. Attention to the toilet—thorough, careful cleansing of the skin—tends to reduce industrial dermatoses.

Dusts in themselves are not infectious. Dusty air is not salubrious, but with the dust evil minimized, as in modern industries, there are few occupations that can be condemned as unfit for healthy men. While the controversy over cement dust still rages, its dangers are far less excessive than some have imagined. The dust menace in other trades is, in comparison, relatively negligible. The inhalation of foreign particles—such as coal, iron, stone, textile fibers, animal hairs and furs, grain dust—gives rise to pigmentation of the lungs. This pigmentation in itself is of no consequence, and everybody has it to some extent.

*Abstract of paper read before the Eighth Annual Safety Congress of the National Safety Council.

Tuberculosis is a house disease; indoor life is largely responsible. It cannot be fairly classed as a trade disease. The purely industrial diseases are but a fraction of a per cent of the sum total of industrial morbidity; they are but a drop in the bucket. The preventable diseases, non-industrial in source, loom large in comparison. Teeth and tonsils, "coughs and colds" cause a hundred times as much sickness in the general industries as do the industrial poisons.

Industrial Health Hazards of Employers

The industrial health hazards of the employers may be grouped as:

1. Decreased production; machines lie idle; sick employes are irregular, discouraged, lack "pep."
2. Excessive labor turnover, due to ill health, unfitness for jobs assigned, prevalence of epidemic and infectious diseases.
3. Increased accident compensation expenditures, due to sickness masquerading as injuries.

The government employs only healthy men for the fighting line, whose ability to recover from wounds is 100 per cent plus. The industries necessarily employ many aged and feeble men, suffering from latent diseases and infirmities, having enfeebled powers of resistance, and incurring delayed recoveries, when injured. Fully "fifty-seven varieties" of sickness are presented as industrial accidents in entering compensation claims. Among these may be mentioned tuberculosis, syphilis, rheumatism, each contributing their quota. These latent diseases, and others, are readily activated by injuries.

Remedies Suggested

Since these health hazards face the industrial manager, what can be done about it? How can they be avoided? Measures to this end are:

1. Industrial Health Clinics, group diagnoses; health service measures; repairing defects; reclaiming those disabled by diseases, as well as those crippled, and fitting them into selected positions in the industries; health education.
2. Legalized releases for defects that cause abnormally long periods of accident disability.
3. Obligatory Post Mortems. When the cause of death is in dispute, the report of the post mortem should terminate the controversy.
4. Federal Health Charts. Transient employes lose a day, undergoing the physical examination that precedes their employment. A Federal health chart, renewed annually, valid everywhere, would be invaluable for the transient worker, as well as for the continuous worker, who remains loyally by his employer year after year.

Employes encounter health hazards apart from industrial service, that revert back, affecting their industrial life. Such health hazards may be grouped as: Inherited Tendencies, Family Problems, Financial Problems, Social Life, and House Problems.

Associating at work, or anywhere else, with persons having active pulmonary tuberculosis is a menace to health. Non-tuberculous employes should be spared the hazard incident to working near employes, who are coughing and spitting, in the active stages of pulmonary tuberculosis.

Personal Hygiene

Neglect of personal hygiene may be listed as follows:

(a) Neglected teeth. The neglect of teeth among industrial workers is appalling.

(b) Diseased tonsils. Tonsillar infections, both locally and by referred manifestations, cause much loss of time in the industries.

(c) The venereal peril. All three venereal diseases, in their infectious stages, should bar employes from industry.

(d) Physical defects, such as hernia, eye strain, etc., known to exist, yet repair and corrective measures are postponed.

(e) Constipation, woefully neglected.

(f) Neglect of home sanitation, ventilation, etc.

(g) Balanced diet, unobserved.

(h) Deficient sleep.

While there are industrial health hazards, and while the zeal in discovering and eliminating them is commendable, the facts remain that the purely industrial diseases are very rare in the general industries; that preventable, non-industrial ailments are the preponderating cause of sickness disability and health impairment.

If a man works hard enough and long enough he will naturally get tired. Industrial fatigue may not be excessive, but the fatigue from other sources, combined with the industrial fatigue, may prove detrimental to an employe. For a man to be fair with himself and with his job, he must ascertain to what extent his job is tiring him out, and to what extent his fatigue arises from other causes. A worker who is constantly fatigued from any cause, or any combination of causes, will lose time now and then from sheer exhaustion. The fatigued worker is more susceptible to infectious diseases, from which he makes a retarded recovery; he becomes more stupid, and because less alert, he more readily meets with accidental injury, from which he recovers slowly, since he has impaired vitality, and we have injury plus sickness to deal with.

Educational effort from within the industries strives to stimulate the initiative of employes into foresightedness along health lines. To what extent the industries can enter into community activities without becoming paternalistic is a debated question. Model house building enterprises—helping employes acquire their own homes—building and loan associations, banking, stores and restaurants on the no-profit basis, clubs, social centers, playgrounds, hotels for employes, industrial and technical schools, apprentice courses with technical schooling, athletics, bands, and glee clubs are among the forms of community enterprise fostered by many of the larger industries, and which have the endorsement and approval of employes.

The new spirit abroad recognizes participation in industry as in the nature of a social service; constructive good-will—based on mutual confidence, and real justice—alone can operate effectively to solve the problems to which industry gives rise. In the trinity of production, Capital, Labor, and the Community must unselfishly co-ordinate their common functions of serving one another.

Twenty Scotch marine boilers have been shipped out by a Portland, Ore., company, 12 of which will go to Shanghai.

Dangers of the Oil Room

EXPLOSIVE AND BURNING QUALITIES OF VARIOUS LIQUIDS; ACCOUNTING FOR OIL USED; STORAGE SYSTEMS. BY S. D. RICKARD

IN CONSIDERING the dangers attendant upon the storage and handling of oils, we are apt to think only of gasoline and naphtha. This is a great mistake, as every oil carries with it a menace to life and property and its handling should be safeguarded in every possible manner. Until this fact is universally recognized and all oils are handled in fire-proof, evaporation-proof steel storage tanks, we must expect to pay an enormous fire loss, due to the careless handling of these products. It is true that the danger of handling gasoline is greater than in handling other oils. This danger is so well known, however, that familiarity with it has in many cases induced carelessness, so that it is well we consider the treacherous nature of this product that we may always be on our guard.

Gasoline, unlike the other heavier petroleum products, throws off an explosive vapor constantly, even at extremely low temperatures. Five gallons of gasoline will generate 8000 cu. ft. of gas, which, when ignited, expands to 4000 times this space. The explosive force of 1 gal. of gasoline properly mixed with air and compressed is equal to 83⅓ lb. of dynamite or 14 times greater than dynamite. This means that if you have 100 gal. of gasoline on hand, you are storing the equivalent in explosive force to 8366 lb. of dynamite. Gasoline is, in fact, more dangerous to handle than dynamite, and there is more liability of an explosion. Dynamite will explode from only two or three causes, which may easily be guarded against and which must occur in its immediate vicinity.

The vapor from gasoline is heavier than air. It settles to the floor and runs along the floor much as a stream of water would, only that it is an invisible stream. This vapor will settle and remain in a depression in the floor or under the floor for days and even weeks, unless disturbed by a circulation of air, until a spark causes the accumulated vapor to explode. This spark does not necessarily have to come from a lighted fire, but may occur through a person striking a nail in his shoe on a nail in the floor or other similar unavoidable causes. The records show that under certain atmospheric conditions, spontaneous combustion will occur in this accumulated vapor. A case is on record in which the gasoline fumes were carried outside of a building to a lighted lamp 30 ft. away from the building, taking fire and flashing back to the building, which was entirely consumed. If you are handling gasoline in any way but the right way, you are in just this position, and you can never foresee when the blow will fall.

It is past understanding, in view of these facts, that many concerns, with their entire capital invested in the business, will give so little thought to safeguarding their interests. With the factory, shop, mill or mine heated, they will at night lock up this explosive in a warehouse or building adjacent to or connected with the main plant. After locking up fire and this explosive vapor together, they will, in effect, wager their entire investment against the merely nominal expense of fire-proof storage that this vapor and this fire will not get together.

Kerosene is not as dangerous as gasoline, yet at a temperature of 70 deg. F. or over it throws off an explosive vapor. At a higher temperature, say 80 deg. F., in order properly to ventilate a room in which there is an open tank of kerosene, there should be kept up a circulation of air equal to 200 cu. ft. per minute for each gallon of exposed oil. These figures vary, of course, with the volatility of the oil and the temperature of the air and oil. Such a circulation of air is not practical in the usual manufacturing establishment. Hence the necessity is apparent for evaporation-proof, scientifically correct storage for kerosene as well as for gasoline.

All petroleum products, including lubricating oils, produce this explosive vapor. The danger from lubricating oils, however, is chiefly from spontaneous combustion where waste, sawdust or shavings are used to absorb the oils spilled on the floors. Many fires in factories and oil rooms have been traced directly to this cause, as it is a common practice to neglect the accumulated refuse, which, in time, bursts into flames.

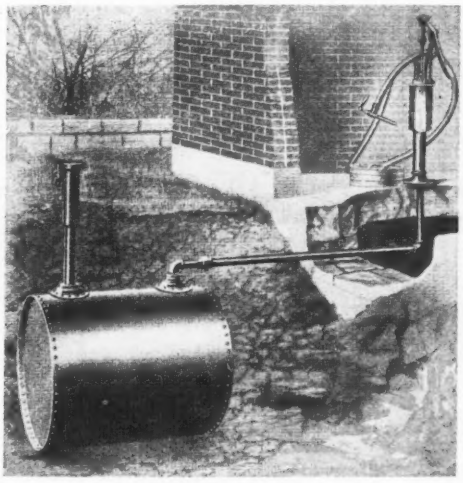


FIG. 1. ARRANGEMENT FOR UNDERGROUND OUTDOOR STORAGE OF GASOLINE

The gravest danger that confronts the consumer of oils aside from the gasoline danger is, however, from the paint oils, such as linseed oil and turpentine. A piece of cotton waste saturated lightly with equal parts of linseed oil and turpentine will, if left in a closed room, such as an oil house or storeroom for the night, burn from spontaneous combustion in three hours' time. Instances are not even lacking of fires being started in this manner when the waste or oil-soaked cloth was left in the open air. Two years ago a fire occurred in Minneapolis from a cloth which had been used in oiling a floor and was left on the porch. North Dakota has, in the past year, suffered a loss running up into hundreds of thousands of dollars from fires started by spontaneous combustion in oil houses. This property loss is appalling, but who can estimate the value of lives sacri-

ficed annually to the mistaken policy of "economy" in equipping an oil room?

Special equipment has been designed for handling each and every oil in a manner best suited from the standpoint of economy, convenience and safety, so that we may in confidence look forward to a time when fires caused by careless handling of oils will be unknown. This will be brought about by various causes. The instinct of self-preservation is strong with everybody, and all must realize the risk in the careless handling of explosives. The fact that these safety appliances conserve the efficiency of the product, preserve the quantity intact and enable losses to be turned into profits brings enormous pressure to bear upon the thoughtful man. Public opinion, national and state safety boards will soon demand that every man will, at least, cease to menace his neighbor's property and his neighbor's life by unnecessarily lax methods in the handling of dangerous explosives.

FIG. 2. SECTIONAL UNIT ARRANGEMENT FOR STORING OIL IN ENGINE ROOM OR OIL HOUSE

Increasing prices of all kinds of oil and general economic requirements demand the proper storage and distribution of these liquids. Millions of dollars are lost annually due to deterioration of the quality, and waste in handling improperly stored oils. Hot and cut bearings and prematurely worn machinery are frequently due to deteriorated or contaminated oil. This enormous loss is rarely traced to the right source—poor oil storage. The same criticism can be made of improperly stored paint oils, varnishes, dryers, etc. Competition in practically all lines demands economical production—that means elimination of waste as far as possible in every department of the industry.

Your oils can be checked in as they are received and accurately recorded as they are used. You can keep just as accurate account of your oils as you can of your tools.

All railroads, miners or manufacturing institutions maintain stockrooms for the purpose of receiving and distributing all of the supplies used by the institution. This is considered absolutely necessary in order to reduce losses and to maintain a cost system.

Money is invested in oils just the same as any other supplies, yet it is a known fact that in most institutions no record is maintained as to the quantities received or dispensed. The purchasing, storing and the distributing of lubricating and paint oils, gasoline, naphtha and other similar liquids is just as much a science and a part of the plant cost system as any other department.

The installation of a modern storage system for oils need not necessarily imply the outlay of large sums. We have found this "big investment" idea on the part of men in charge of industrial institutions has frequently prevented them from considering the purchase of equipment. It is not always necessary, or even advisable, to put in at one time all the equipment the management might feel would be needed ultimately. In many instances, storage is provided for those oils or other liquids which most urgently require it. The balance of the equipment can be added as finances permit or exigencies demand.

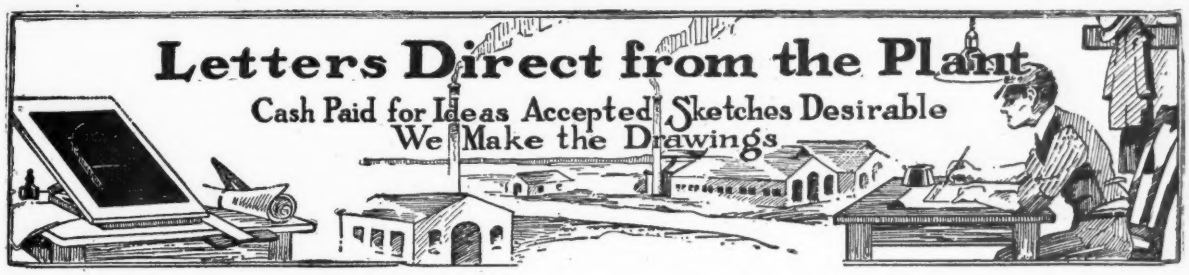
Modern storage equipment for handling liquids is really divided into two general types. One for handling volatile liquids, such as gasoline, naphthas, paint oils and varnishes, and the other for handling non-volatile liquids, such as lubricating oils.

The first of the two general types requires underground storage tanks for gasoline or naphtha and above-ground storage for the paint oils and varnishes. This arrangement usually meets with the demands of the various state laws governing this type of storage. Where underground tanks are required, they should be cylindrical in design, Fig. 1. If made of galvanized steel, all seams and rivets should be carefully made and then soldered inside and out. If heavy metal is used, such as 3/16-in. steel, or heavier, as conditions or the capacity of the tank may make necessary, then all seams and rivets should be carefully calked. Storage tanks for volatile liquids require special care in construction. A tank may hold water or steam pressure, but it is usually unfit for volatile liquid storage purposes.

If above-ground tanks are essential, these are made in rectangular shapes, Fig. 2, the height and length remaining constant and the width varying according to capacity desired. This arrangement permits the addition of other individual units to the system and does not destroy the uniformity of the battery of storage equipment. Rectangular tanks are made with the same care as the cylindrical designs.

Specially designed pumps of either measuring or non-measuring type are connected by pipe lines to tanks buried underground or inserted in the top of tanks for above-ground use. Accurate devices are provided on the measuring pumps for the delivery of desired quantities of liquid. Gear driven meters may be added for the purpose of checking consumption. Locks are supplied on both types of tanks and on the pumps as well. This prevents unauthorized usage and theft.

Where a battery of individual units is used, barrel track and barrel drainers are used in connection with small chain hoists, Fig. 2. This makes it very easy to handle the barrels and drains them completely into the manhole of the tanks, saving labor, time and liquid.



Protection of Blowoff Pipes

REFERRING PARTICULARLY to blowoff pipes connected with horizontal tubular boilers, I wish to say that I did not have the same satisfactory results with circulating pipes as Mr. Thorn describes in the Nov. 15 issue. In the first place, if a blowoff is not protected from the heat, it is made a part of the heating surface connected with the boilers. It is a water tube located below the bottom line of the boiler and it will receive the feed water, which drops to the lowest point due to being at a lower temperature than the water in the boiler. This causes expansion and contraction to take place in the blowoff every time feed water is admitted to the boiler.

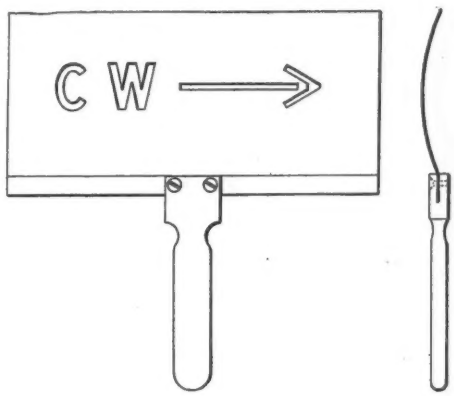
The water at a lower temperature contains scale-forming matter held in solution, which is separated from the water when it is heated to a high temperature and which will adhere to the inside surface of the blowoff pipe in the same way as in water tube boilers, which have to be cleaned with turbines to remove the scale.

The writer has had the above experience with horizontal tubular boilers using returns from a larger heating surface and raw make-up water which contained from 6 to 8 grains of solids per gallon. It is impossible to remove the scale formed on the inside surface of a blowoff pipe by simply opening the blowoff valve, even if they were opened every hour. I removed the circulating pipes and used a protection of brick and insulation material, which proved to be very satisfactory in protecting the blowoff pipes for the past 7 yr. The pipes were found to be free from any accumulation of scale when inspection was made about one month ago. I am of the opinion that Mr. Thorn is located where the water is free from hardness.

As stated above, a water tube exposed to high temperature will liberate the hardness held in solution in the water and in time obstruct the blowoff pipe. Recognized engineering authority is the best proof for this statement and practical demonstration makes it a fact. I do not agree with Mr. Thorn's suggestion to be on the safe side and cover both the circulating blowoff pipe and blowoff pipes without circulating connections. If the circulating blowoff pipes are covered or insulated, there would be practically no circulation, and it would mean a useless added expense for the extra pipe fittings and time to make extra connections. T. SUTCLIFFE.

Marking Pipe Lines

IN MANY PLANTS the pipe lines are so marked that the operator can tell at a glance the service they are rendering and the directions of flow of the fluid. Stencils can be made from sheet tin and attached to a handle with a couple of ¼-in. stove bolts, as shown in the sketch. A handle can be made for each stencil, or the one handle can be used for many stencils. The tin forming the stencil can be bent as shown. The full letters or words can be used, such as "steam" "cold water," etc., or letters with the arrow, C. W., being for cold water. Various colors may be used for each line, as red for cold water with extra letters for fire line, supply line, etc.; blue for hot water; green for steam; black for gas; white for exhaust, and so on. If the lines are marked at frequent intervals, it is even a better plan than having each line painted a different color over its entire length with no other markings, for where there are numerous lines with many colorings a workman may forget the color for some line, but with the letters and arrow the direction of flow and contents are instantly shown.



DETAILS AND ASSEMBLY OF STENCIL FOR MARKING PIPE LINES

No claim is made that this idea is original; it has often been used; however, it is a good tip to pass along.
JAMES E. NOBLE.

That National License Law

I HAVE READ with interest, the several articles on the subject of a National Engineers' License Law, which have appeared in the columns of Power Plant Engineering.

I do not believe we should limit the idea to engineers and firemen, for there is practically as much reason why operators of gas engines and hydro-electric plants should be licensed also. Of course laborers and helpers should be allowed to work without a license until they could obtain enough elementary knowledge to pass an examination for a fireman's license.

I worked myself up in the trade until I became chief in a good-sized plant and have held several positions as such; but I was always dissatisfied with conditions, due

to the fact that anybody who chose to call himself an engineer could get a job. I finally made up my mind to go to a state where a license was required and see if conditions were not better, and I came to this state and applied for a first class license. Needless to say, I did not get one; but upon my second trial, I found that while I claimed to have been studious and observing, there was really not much I knew well enough to be sure of, and no apologies are accepted by a board of examiners. A man must have the required knowledge if he expects to get a license.

I am more than glad, however, that I came to a license state, for I found how little I really knew and then I was on the right road to learn something and I have also reached the conclusion that a man will learn more in a state requiring its engineers to be licensed, than in a state which does not.

The real trouble with myself was the same as in all such cases. There had been no real incentive for me to get right down to the very bottom of things, therefore I had neglected to do so and when I went up against a board composed of men who knew their business, I was simply stuck and was ashamed to have claimed to be an engineer. It is certainly worth any man's time and trouble to go before a board of examiners and try for an engineers' license, for the sake of finding out how little he really does know compared with the knowledge with which he has accredited himself. Another thing I am sure of, is the fact that the only ones opposed to engineers' license laws are outsiders who would like to work here but have not the necessary knowledge to obtain a license. Engineers and firemen who have been unable to get as high a license as they wish, through lack of knowledge or by having violated the law, and of course many of the plant owners do not like the idea because they are of the opinion that they will some day have to pay licensed men somewhere near what they are worth. It is the fault of the engineers themselves, however; for, had they been willing to help each other from the start, which is the principle of such organizations as the N. A. S. E., there would be a very different state of affairs today and every state would have a license law.

Unionism will bring about the desired conditions, but not the kind that most people expect; for there is not enough of the educational idea written into the constitutions of the labor organizations, but more of a tendency is shown for the encouragement of the inefficient ones to lean upon those who are efficient rather than to become better men themselves. This is a block to the wheels of progress and no one gains by it except the man who has not enough gumption to earn his share, stand upon his own feet, and there are hundreds of thousands of that kind in the country today. Where it is compulsory for a man to learn more, to earn more, such men will either fall in line and try to do what is right, or find themselves slipping fast.

I am not opposed to organized labor if properly managed and I know that it has accomplished a great deal and that labor has organized because it realized the need of some way to make its demands collectively, knowing the futility of individual effort along that line; but I do not believe that labor will contradict me when I say that there are many unsatisfactory things about organized labor.

I believe that if every real engineer and fireman in the United States would join the N. A. S. E., and lay aside all personal grudges and petty jealousy and live up to the precepts of the Association, we should accomplish more toward obtaining the conditions which we should have than all the engineers' and firemen's organizations put together have been able to accomplish up to the present time. And we would do it wholly by means of education and legislation.

There is nothing in the constitution or by-laws of the N. A. S. E. which forbids a member from joining a labor union, neither is there anything which prohibits union men from joining the Association.

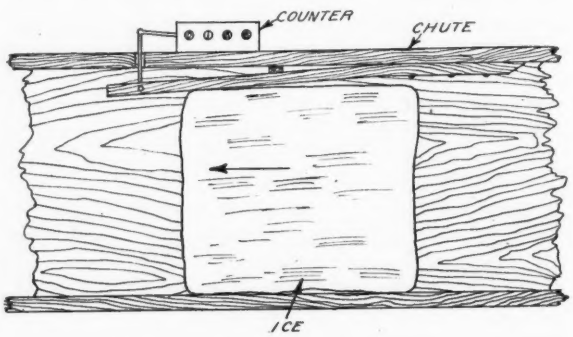
The unions have adopted the principle of collective bargaining and the N. A. S. E. has adopted the principles of education and legislation; I believe the latter to be the surest and best way and I sincerely believe it will win.

One of the best things that is accomplished by the enactment of a license law is that a person cannot become an engineer overnight for the law requires him to serve a reasonable time in all branches of the trade, and certainly no one should have charge of a steam plant who has not worked his way through a plant and does not know what the work is and how to do it. Without actual working knowledge he could not be fit to handle his men, for they would soon learn the extent of his knowledge. Let us get together as men and help each other, and all work toward the enactment of a National Engineers' License Law.

L. M. Reed.

Counter on Ice Chute

The writer recently visited an ice plant where the engineer had rigged up an ingenious device for registering the quantity of cake ice sent down the chute from



ARRANGEMENT OF COUNTER AND TRIP

the storage room to the shipping platform. A 12-in. wide strip of ¾-in. tough, but resilient wood was attached to the side of the chute, one end of the board projecting out into the chute-way far enough so that an ice cake could not pass without pushing it back about 1 in., the heavy ice cake having force enough to do this readily. The loose end of the board was then connected with a rod to the lever of an ordinary dial counter, so set that each time the board was pushed back, the counter registered one. The counter totals were taken each day or at suitable intervals.

M. A. Saller.

Depreciation of Steam Plant

I NOTICE in the Nov. 15 number of Power Plant Engineering an article by Mark Meredith on "The Depreciation of Steam Plant" he states that 16 yr. is about the average life of high speed engines.

I have a 150-hp., running at 230 r.p.m., that was started in November, 1903, and has been in service every day since, running 15 hr. per day except Sundays, and it runs through from Saturday evening until Monday morning.

The cylinder has been rebored once, and the governor has had three new bushings. This ends the expense of this engine in the way of repairs.

One thin paper shim has been placed between the crosshead and bronze slipper. I run the crankpin an average of 3 yr. without adjusting and the shaft bearings about the same.

The crosshead or wristpin has not been out for 2 yr. Tool marks are quite visible in the lower guide; you can also see scratches on crank and shaft bearings that were made in the shop.

With the aid of a micrometer you might detect a small wear of the bearings.

I have a 300-hp. Corliss that was started at the same time running on an average of 10 hr. a day except Sundays that has never had any work done on it except centering piston rod in a built-up piston and packing the steam valves.

The best motto for an engineer is to get his engines adjusted just right, then let the wrenches hang on the board; if they get cobwebbed, dust them off.

O. KYGER.

Ice Plant Explosion; Blowoff Pipes

I HAVE OBSERVED this article in Power Plant Engineering of Nov. 15, page 1026. They say "ignorance is bliss," and sometimes works hand in hand with main force and awkwardness, which seems to be the manner pursued in attempting to test out this plant. According to Mr. Storey's version of this affair it was a serious time, no doubt, for those nearby, yet amusing to an old refrigerating engineer. I am sure that when our brother mechanic attempts to test out another plant, however small or large the job, he will not only watch his pressure gages like a hawk, but will test them out first of all to see that they are recording accurately. His next step will be to overhaul and test out his relief valves, so that when he does try the plant out, should his pressures run up beyond his control they will allow the excess pressure to escape into the atmosphere, instead of endangering lives and wrecking the entire plant, and possibly other property.

John Thorn's article in the Nov. 15 issue of Power Plant Engineering, page 1027, commenting upon L. A. Cole's letter on page 933 of Oct. 15 issue, is worthy of careful consideration. Mr. Thorn's idea of power plant engineering is entirely correct as to the varied experiences of different engineers even with the same kind of machinery.

Some engines require a great deal more of the operator's personal attention than others of the same make. Mr. Thorn's theory of a circulating pipe arrangement upon a blowoff line of a boiler is not only theoretically correct, but, from a standpoint of practice where it receives the care and attention it should receive, it will prove financially beneficial.

No doubt, few engineers have been confronted with the seriousness of this feature because they have never encountered much trouble along these lines. To make it clear as to the advantage of this circulating pipe, it is simply this: In boilers not running up to capacity the heat in the furnace is not nearly as great as when a boiler is running up to its peak load or above it, and in that case this device would never be missed; but on boilers that are worked above their capacity this arrangement is seriously needed, owing to the fact that we have the blowoff line, which in reality is a dead line, and the heat in that portion of the furnace is so severe that it turns the water into steam, which partly fills the pipe. Portions of the pipe that contain no water will eventually crystallize and burn or blister. If the blowoff line, according to Mr. Cole's theory, had two outlets to it as in the circulating blowoff pipe connection, the pipe then has a continuous circulation of water in it.

I am of the opinion that few engineers are confronted with overloaded boiler problems; that is the reason we have seen so little in this line of discussion.

I had occasion several years ago to assist an engineer friend of mine out of trouble somewhat similar to this in some water-tube boilers. I found, after analyzing the question carefully from a standpoint of the size of his boiler, that the first and second rows of tubes in the bottom of his boiler, which were being replaced after a usage of from one day to three weeks, would show long cracks from 6 in. to a foot long, and severe blisters and bags. I arrived at the conclusion, from my information, that the circulation of water was so great or swift in these tubes that the water either went through them in gushes or they were partly filled with water and steam. After another unit was installed, based upon what the theoretical overload was, all of this tube trouble was eliminated. I presume that Mr. Thorn's experience and theory of blowoff pipes will fully coincide with this theory and experience of mine. H. W. ROSE.

Safety First

QUEER STUNTS are sometimes pulled off in the engine room, which result in needless expense, loss of time, and sometimes loss of life. They are often the result of ignorance, sometimes carelessness, or other causes. A valve rod on a small Corliss engine broke recently and the engineer replaced it and attempted to start up. Some cause or other, probably the governor being below the safety stop, threw the safety cams on the knockoff levers in action; the hooks would not pick up the steam valves, so the engineer took a hammer and pounded the hooks until they would catch. The other engineer, coming on duty at that time, suspected things were not as they ought to be, so he told those in authority that a man from the builder's factory ought to be sent for. He knew enough about the condition of the engine to know he could not get it O. K.

The upshot of the matter was that a man was sent for and he went over the rods and reset the valves, then, everything being clear, started the engine slowly. He then attempted to block up the governor to adjust the cutoff before giving the engine full speed, whereupon it was seen that the hooks did not release, and would not

release even though the tail of the hook rode up on the thickest part of the knockoff cam. Looking closely, he found the hooks bent, and they had to be taken off and straightened.

After the hooks were replaced, the engine was indicated and all was again serene. Now, suppose that engine had been started up and the throttle opened wide to bring it up to speed, and the engineer, thinking all was well, had gone into the boiler room to attend the fire. The engine would have gained speed, and the governor not controlling it, a runaway would have been the result.

At another place an idler was placed on the governor belt, and connected to this idler was a rod up to the governor stop, the idea being that, should the belt break the idler in falling would turn the stop so the governor would drop low enough for the safety cams to get into action. This part was well enough; but suppose the pulley or mitre gear on the shaft driving the governor should become loose and fail to revolve the governor. The governor stop being held in place by the idler and the governor dropping down on the stop the engine would speed up above normal and unless checked the result would be a wrecked engine.

An engineer once removed the piston of an engine in order to examine the condition of the packing rings; but there were no tram marks on the rod to show how far it had been screwed into the crosshead, nor did he make any, and when he replaced the piston he screwed it in about where it was before—as near as he could remember. Had he put the engine on the dead center he could have measured his clearance even then, and turned the engine over to the other center, looked in the steam pot and seen his clearance at the end. He did not do this, but closed up the cylinder and gave the engine steam. The result was that the crank broke off; but the engine was not damaged otherwise, with the exception of the connecting rod being slightly bent.

TOM JONES.

Fuel Oil

IT IS with extreme interest and much pleasure that I have read and noted the method of firing crude oil under steam boilers according to the theory of Charles W. Geiger in Power Plant Engineering, Oct. 15 issue. I was one of the first engineers in the south to use oil for fuel when the Spindle Top oil fields of Beaumont, Texas, were brought in.

An oil setting for boilers of the type shown in Figs. 5, 6 and 8 of Mr. Geiger's article, which will discount these settings by 25 per cent or more in the saving of fuel bill, is secured simply by taking out all of the brick, grate bars, bridge wall and dirt which he has piled in the combustion chamber and allowing all of the combustion space for the fuel which can be acquired. On each side of the boiler walls to halfway up the ash pit doors, run a wall of one brick thickness, the length of the original grate bars, fill in with brick the remainder of the ash pit doors, and brick up air-tight, clear across the boiler at the rear end of these two single brick walls. Run a single brick wall halfway between these walls and place upon the top of these three walls, pieces of 2-in. pipe that will reach from one side of the boiler to the other. Fire brick are then placed on edge on these pipes to form a checkerwork. This will allow the oil and air to mix thoroughly. The fire doors can be bricked up solid with the exception of a hole left for a burner to enter and to get a torch into the furnace to light the burner. The ash pit doors can be left on to assist in regulating the draft in connection with the stack damper. Boilers where crude oil is to be burned permanently are set about 3 ft. higher than for wood or coal as the increased combustion space underneath the boiler greatly increases the efficiency for fuel oil. The setting in Fig. 7 of the Scotch Marine boiler is also deficient in economy, as I have had to readjust settings of this type in the Galloway boilers, which are somewhat similar. I recommend taking out all of the brick in the fire box with the exception of a network in the extreme end placed like pigeon holes, but leave the ash pit door as it is, as it is needed to assist in regulating the draft. The brick work keeps the fire directly off the tubes which owing to the short length of the fire box have to be renewed about four times a year.

In fire box boilers, best results are obtained by placing a solid bridge wall in the front of the boiler, and having the burner in the lower portion of the rear of the fire box, throwing the fuel directly up against this fire wall takes this continuous direct heat off the crown sheet and tubes and lengthens the life of the tube by 50 per cent.

All fuel oils will work successfully at from 75 to 100 lb. pressure on the burners and at about 125 to 150 deg. F. in the storage tank, and after passing the pump and reheated in the heater on the way to the burner to from 175 to 225 deg. F. H. W. ROSE.

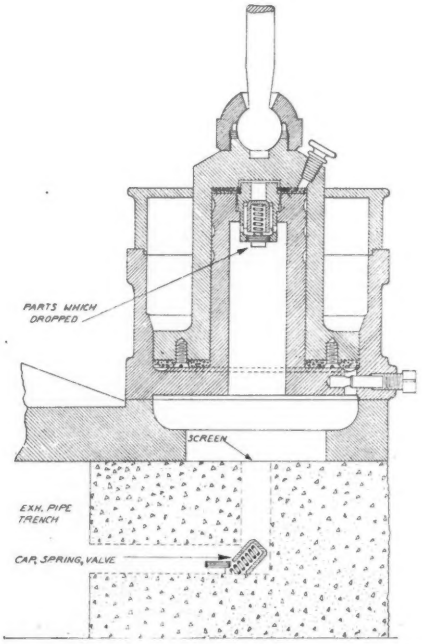
Routine Inspections

IT IS a platitude to say that nothing ever happens without a cause, but in practice it is very often difficult to trace effects to their ultimate causes. Particularly is this frequently the case with power plant and machinery in general, because there are generally several contributory reasons tending towards breakdown. It is the function of good design to eliminate as many as possible of these weaknesses and to produce a mechanism which shall have within itself self-adjusting tendencies rather than those likely to produce rearrangement; but in so far as no human brain has yet devised means for circumventing wear and tear, design cannot entirely obviate breakdowns.

In the operation of plants, therefore, the efforts of engineers must always be directed towards the renewal of apparatus before its wear causes trouble rather than the replacement of parts which have given way and thereby may have caused disorganization of the running plant. This can best be done by a system of routine inspections, whereby all parts liable to wear or even liable only to occasional movement and hence to sticking, are periodically examined and renewed or refitted before failure can take place. Unfortunately, routine work of this kind is always uninteresting and few engineers will appreciate its importance sufficiently to maintain such a routine in constant use without frequent encouragement, hence the necessity for a system requiring initials in a log-book for each examination. The importance of these routine inspections has been proved in practice in innumerable cases.

A Dashpot Kink

AN ANNOYING mishap recently occurred in my engine room. Trouble was indicated by bad flapping of the belt from a Corliss engine to generator, with accompanying fluctuation of the voltage. I traced the trouble to the head end dashpot and shut down, expecting to find the spring in the air valve broken. Upon taking the dashpot apart I found that the cap holding up the spring and valve had dropped to the bottom of a 1½-in. hole about 8 in. deep, connected at the bottom to a horizontal one of about the same size, this hole being provided to carry off the air discharged from the pot to the exhaust pipe trench.



DASHPOT SHOWING LOCATION OF SCREEN TO PREVENT FUTURE DELAYS

It took about half an hour probing and fishing with various sized hooks and rods before I recovered the spring, valve and cap. A few minutes sufficed to reassemble the pot and I made sure a similar trouble could not occur by placing a piece of brass screen, cut to fit the hole, over the opening. I also, the next day, placed a similar piece of screen over the opening of the other dashpot, thus preventing a possible future delay.

I have had several trivial things cause shut-downs before on this engine, a few minutes' work generally making it all right again. The actual time required for replacement on this last occasion was trifling; it was the securing of the parts which caused the delay. The more experience I get with power plant machinery the more I am impressed with the value of little things.

The accompanying drawing explains the circumstances and shows where I placed the screens, and may be a suggestion for somebody else to follow before a part works loose. HARRY H. YATES.

Repairing a Crowfoot

SOME TIME ago my fireman broke a crowfoot, and not having any means at hand by which I might weld it, I proceeded with the repair job as follows: Having found a piece of iron rod of such size as to allow the cutting upon it of a ¾-in. pipe thread, I split it and bent it as

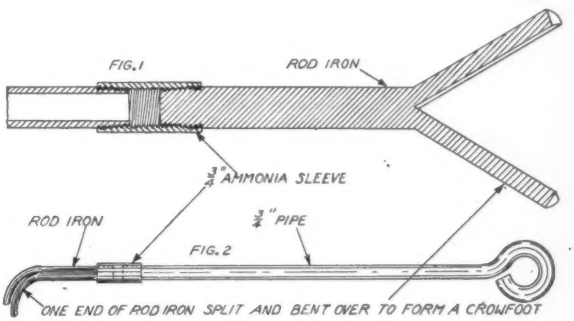
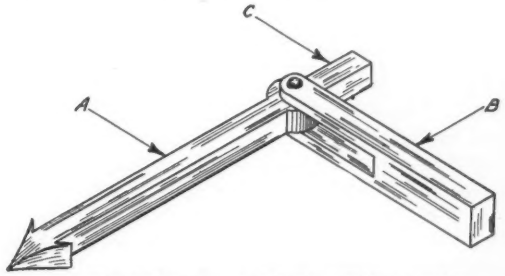


FIG. 1. METHOD OF MAKING NEW CROWFOOT
FIG. 2. MODE OF ATTACHING CROWFOOT

shown in Fig. 1. I then cut a like, but right-handed thread on the handle and with a ¾-in. ammonia sleeve joined the two pieces. R. F. MUELLER.

Packing Removal Tool

SHOWN herewith is a handy tool for the removal of the packing rings of vertical or horizontal pump pistons. This puller, which can easily be made by any engineer,



A READILY MADE PACKING REMOVAL TOOL

consists of member A made up into the form shown from a ⅜ by 12-in. steel rod and a handle, B, of metal or wood.

Striking head C of member A with a hammer will force the tool to enter the packing in such a way that, due to the sharp prongs, the packing will have to come with it upon removal. OTTO DORTHEN.

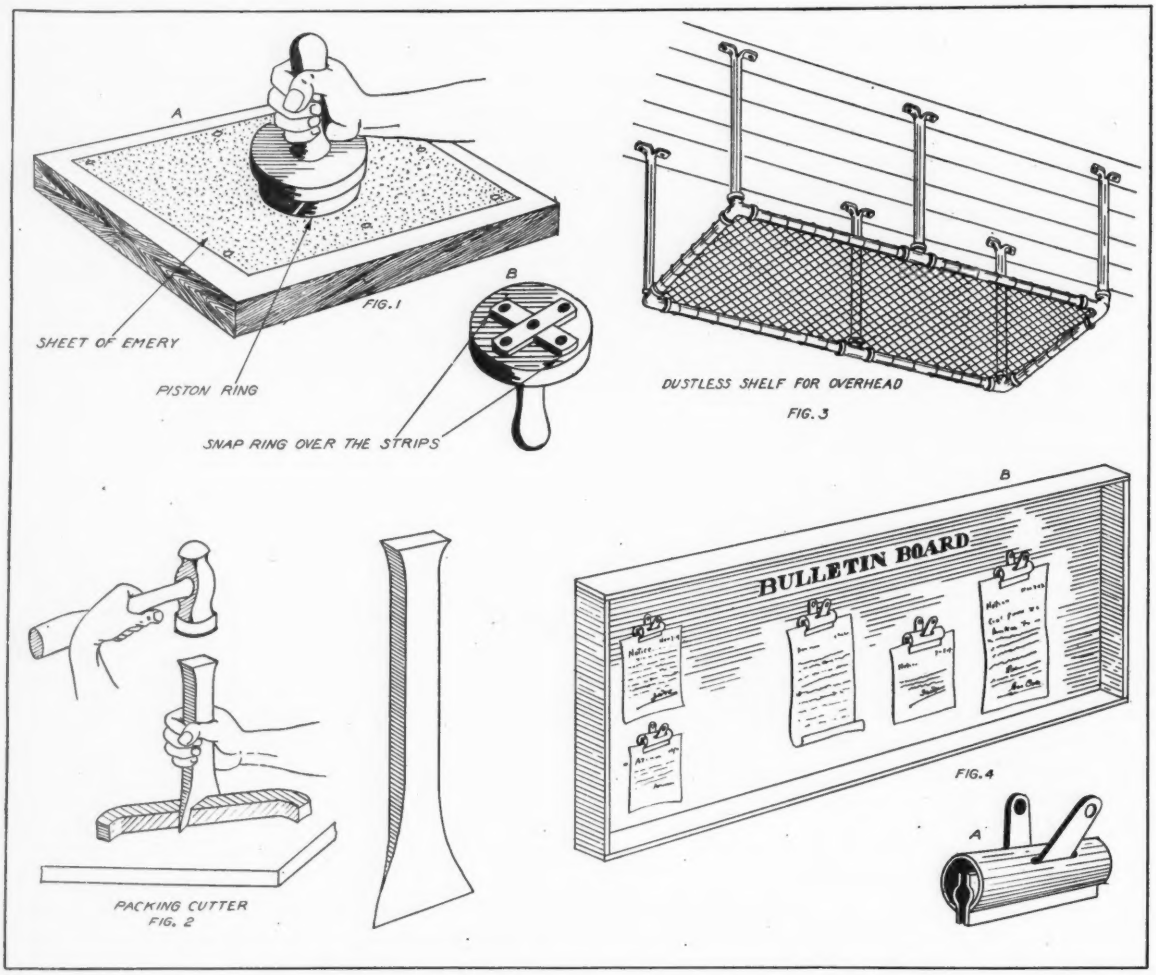
Kinks for the Power Plant

WHEREVER small engines are used, there is need of a suitable rig for lapping in the new piston rings and as I had several motors to take care of, I devised this holder, Fig. 1, for making the work easier. It consists of a round disk of well seasoned hard wood, the under side of which is turned true. On this two strips of wood of slightly less thickness than the width of the rings are secured, as indicated at A. The outside diameter of these strips is such that the ring is held by snapping it on over them. A handle is put on and the lapper is used as shown at B.

Figure 2 may seem almost too simple an idea to occupy space in these columns; but it is noticeable that many engineers do not think of these simple ideas and unless reminded of them, do not get the benefit of other fellows' stunts. There are always plenty of worn-out flat files to be had and one excellent tool that can be quite easily made is that shown in the sketch—a broad, thin blade packing cutting tool.

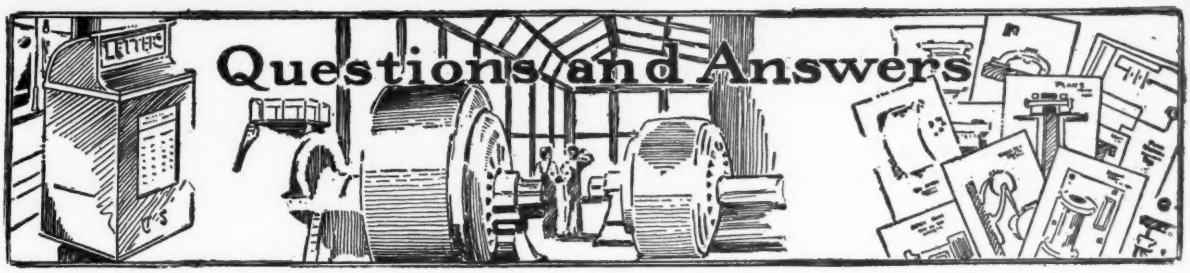
By the use of some pipe and fittings, a frame can be constructed easily for an overhead shelf with heavy galvanized screen wire used in place of boards, the screening being lashed to the pipe frame with wire as shown in Fig. 3. This makes a dustless shelf. The ends of each vertical leg of the pipe frame are split open and bent back to form feet by which the frame is secured to the ceiling.

The ordinary spring clips of the type shown in Fig. 4-A make excellent clips for the bulletin board. These are secured by a screw through one of the holes in the handle, as shown, and used on the board as illustrated in Fig. 4-B. C. W.



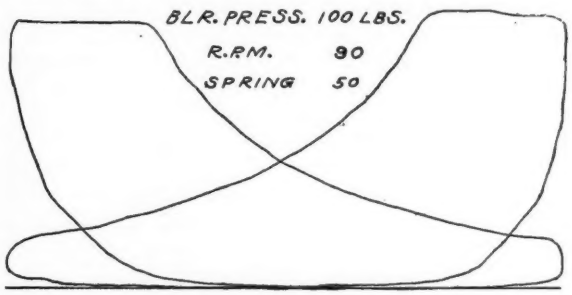
FOUR SIMPLE, BUT PRACTICAL KINKS

WALL ST. JOURNAL states that the output of fuel oil by refineries of U. S. in August amounted to 685,702,461 gal., compared with 638,185,469 gal. in July. Kerosene production continues to increase. Increase in lubricating oil output during August was 5,882,800 gal. over July output.



Indicator Card Criticism

I AM SENDING a card taken from a 14 by 36-in. Corliss engine. This is the first card taken after 10 yr. service. The engine was under full load, and is noted for quiet

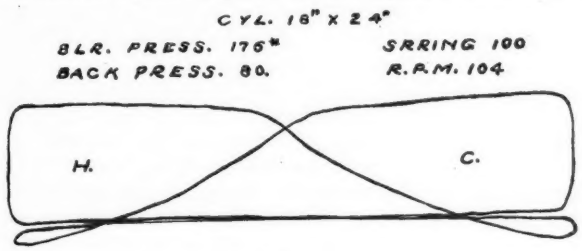


WHAT IS WRONG WITH THIS CARD?

running. I would like to have some of the readers of Power Plant Engineering criticize it. G. B.

What Causes the Knock?

I PRESENT here diagrams from an 18 by 42-in. Allis Chalmers Corliss engine working against 80 lb. back



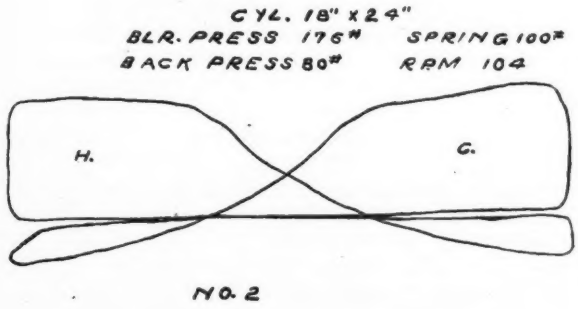


FIG. 1. OPERATING UNDER FAIRLY GOOD LOAD
FIG. 2. SAME ENGINE UNDER LIGHTER LOAD

pressure which is used for drying sugar beet pulp. The boiler pressure at the time these cards were taken was 176 lb. The engine runs fairly well, with a slight knock. The boiler pressure is supposed to be 200 lb., but the engine knocks so badly that I cut the pressure to 176 lb. What I want to know is, how much compression this engine should have under the conditions. The main bearing has burned out every 4 mo. for 6 yr. on account of the pound in the main bearing and the crankpin bearing. The engine runs better since I took charge of it one month ago, but there is still a little pound which I would like to get rid of. The diagrams were taken with a 100-lb. spring, boiler pressure 176 lb., back pressure 80 lb., r.p.m. 104, with a fairly good load. The steam valves have ¼-in. lap with the dashpot down; port opening with wristplate on center, three-fourths the width of port; 1/16-in. lap wristplate on center, and ⅜-in. compression. There is a double eccentric 450-hp. engine on an 800-hp. frame. J. O.

What Caused the Cake?

I AM IN CHARGE of three Stirling boilers which are running pretty hard for 16 hr. out of 24. The other 8 hr. one boiler is enough. One morning the fireman started to blow down the boiler that runs 24 hr. The blowoff was clogged and I shut the boiler down, and by blowing down through water back and pumping in water at the same time I gradually got the steam down to 20 lb. at 4 p. m. The afternoon man did the same. The night man came on at 12 and emptied the boiler through the water back. He then took off the blind flange from the blowoff and rodded the pipe to the elbow at the bottom of the drum. The plate of the bottom drum was then taken off and the water syphoned out. As his attention was taken up with the other boilers, there was no more done with the dead one. I came on at 8 a. m. and immediately started to wash out the boiler. I sent a man into the drum to rod out the pipe to the elbow, when he discovered a cake over the blowoff. It was ⅝-in. thick and a couple of feet long. What was the cause of the cake? The boilers are blown down every watch and were not washed out in 12 weeks. T. F.

Compressed Air and Refrigeration Problems

I WOULD like to hear from somebody who has tried to eject water from a hole with compressed air. I have tried it, but had no luck. I found that it would not lift water at all with 100-lb. air pressure. Steam worked fine. Please explain whether it can be done and how, and if it can't be done, why not. I would also like to know why I can't freeze back on our ammonia compressor. It has been in operation for 2½ yr. and has never given any trouble, but it used to freeze back on the compressor when the ammonia circulated too fast; that is, got low

in the receiver. Now, however, it does not matter how low the receiver gets, our suction line at the machine shows no frost. Is this due to not using enough ammonia, or is it getting weak? I have charged only about 100 lb. into the system in the 2½ yr., and the machine runs seven days a week about 7 hr. a day throughout the year. Any suggestions would be appreciated.

E. S. R.

Loading Capacity of Helical Spring

KINDLY FURNISH me the necessary formula by means of which I may be able to calculate the load capable of being supported by a helical spring such as employed in safety valves. Also give an example. W. E. T.

A. The formula for the load supported by a steel spring of round section material is as follows:

$$P = 1{,}575{,}000 \frac{F\,d^5}{h\,D^3} \text{ or } 31{,}400 \frac{d^3}{D}$$

where P = pressure
F = total deflection under load P
d = diameter of bar from which spring is made
h = solid height of spring
D = mean diameter of spring.

For example we are taking a steel spring consisting of 8 coils of ⅜ in. around steel coiled to a mean diameter of 2 in. The solid height (no. of coils x diameter of metal) 3 in. total deflection ¼ in.

Substituting the given data in the above formula, we have

$$P = 1{,}575{,}000 \times \frac{0.25 \times (0.375)^5}{3 \times (2)^3} =$$

$$= 1{,}575{,}000 \times \frac{0.25 \times 0.007{,}416}{3 \times 8}$$

$$= 1{,}575{,}000 \times \frac{0.001{,}854}{24} = 121 \text{ lb. approximately.}$$

Where the spring is made of rectangular section steel, a different formula is used as follows:

$$P = \frac{26{,}700\,b\,t\,\sqrt{t^2 + b^2}}{D}$$

where b = width of rectangular bar
t = height of rectangular bar
D = mean diameter of spring.

Electrical Heating Problem

IN THE ELECTRIC heating problem in the Nov. 1 number, we will assume that it is desired to bring the temperature of the office up to 70 deg. F. within 45 min. after turning on the heaters, and to provide sufficient capacity for this purpose. A system designed merely to maintain the temperature noted would take an abnormally long time to heat up the cold room and would prove unsatisfactory. We will also assume conduction losses of 5 per cent on account of the large window space, although this factor is often neglected entirely, and, further, that the air in the room is completely changed every 15 min. If artificial ventilation is employed or if the building is not tightly built, the air may be completely changed oftener than every 15 min. If the doors are not opened often, and if doors and windows are equipped with weather strips, change of air may occur only every half hour or every hour; however, the latter figures would probably not represent adequate ventilation, particularly if a large number of persons were working in the office.

Let V = volume of air in room in cubic feet. v = rate of changing air in room in cubic feet per minute. T = time in minutes allowed for heating cold room to 70 deg. t = degrees rise in temperature of room air to reach 70 deg.

The expenditure of 18 joules will raise the temperature of 1 cu. ft. of air 1 deg. F. Therefore, $18Vt$ joules will produce a temperature rise of t degrees in V cu. ft. of still air. To obtain $18Vt$ joules in T minutes, work must be done at the rate of

$18Vt \div 60T$ or $0.3Vt \div T$ joules per sec., or watts (1)

not allowing for conduction or convection losses. Since the air is changing, it will be necessary to increase the above quantity to compensate for convection losses. To maintain a constant temperature elevation of t deg. F. in air changing at the rate of v cu. ft .per minute, energy must be furnished at the rate of

$18vt \div 60$, or $0.3vt$ watts (2)

For the first T minutes, therefore, work must be done at the rate of

$0.3Vt \div T + 0.3vt$ or $0.3t[(V \div T) + v]$ watts (3)

and afterward at the rate of $0.3vt$ watts, to maintain the required temperature. Correcting the above formula for 5 per cent conduction losses we have

$0.315t[(V \div T) + v]$ watts (4)

and $0.31vt$ watts, respectively. (5)

Problem: V = 74 by 32 by 16 ft. = 37,888 cu ft.
v = 37,888 cu. ft. in 15 min., or 2522 cu. ft. per min.
T = 45 min.
t = 70 deg — 26 deg. = 43 deg. (on coldest morning).

Wattage for first 45 min. $= 0.315 \times 43\ [(37{,}888 \div 45) + 2522] = 45{,}563$ w. Wattage after first 45 min. $= 0.315 \times 2522 \times 43 = 34{,}140$ w., which would be required to maintain 70 deg. with 26 deg. outdoor temperature. With an average temperature of 48 deg. t becomes 70 — 48 = 22, and therefore $0.315 \times 2522 \times 22 = 17{,}477$ w. would maintain the required 70 deg. Other computations for various conditions can readily be made.

The quantity v is rather difficult to determine unless artificial ventilation is employed, in which case it may be approximated if the capacity of the fan is known. There remains, however, the matter of additional ventilation through the opening of doors and on account of cracks and crevices in floors and walls and around windows, which in old buildings may be considerable.

In the problem under consideration eight or nine 5-kw. heaters will probably prove adequate. If these should be of the single heat type, several would ordinarily be turned off after the room has been brought up to the required temperature. L. C. PETERMAN.

Protecting Ship Hulls

IN THE Sept. 15 issue, page 808, is an article on painting galvanized iron. I would be pleased to know from Mr. Meredith whether he considers red lead as good for

covering galvanized iron (after washing) as yellow ochre ground in linseed oil and thinned with varnish.

I have in mind painting a galvanized iron hull on a boat. K. T.

A. It would be better to prepare the galvanized iron in the way mentioned in the original article and then superimpose on that a coat of good anti-fouling composition.

In the first case, it is only the effects of rain-water that have to be combated, whereas, in the case of a boat, there is the chemical action of sea-water to conquer. From my own experience, I should think that river water or sea water will in time eat through any preservative coating whatever into galvanized iron, as the best ship steel should always be used for boat work.

On the other hand, if the galvanized iron were not to withstand sea water, I would suggest that a coat of red lead be painted on it in addition to the yellow ochre and linseed oil. MARK MEREDITH.

Why the Stop in Flow?

I HAVE OBSERVED the article by a perplexed engineer in Power Plant Engineering of Nov. 15 issue, page 1031, and after analyzing his problem, and assuming that the water line of 5100 ft. is installed according to the sketch, I am of the opinion that one serious mistake is that he appears to be taking the water from the reservoir at about the top of it, instead of within 1 or 2 ft. of the bottom of it.

I note air vents, according to his sketch, at different distances apart. These are unnecessary if the water always covers the outlet from the reservoir. By taking the water from the top of the reservoir, if the water is stirred up by winds and unsettled conditions, there is more or less air entering the pipe, and after this mixture fills the pipe it is much lighter than it should be; so much so as to hold it almost air bound.

I am sure that his trouble, according to his sketch, lies in his improper pipe connections at the reservoir. H. W. ROSE.

HAD PERPLEXED ENGINEER made a more explicit explanation or given a diagram of the connection of his pipe line at the outlet of the reservoir and stated whence his water supply came, I might have had a better foundation upon which to solve the difficulty.

Whether the water in his reservoir comes from springs or is furnished by pumps and other machinery in connection with wells to replenish its supply, Perplexed Engineer did not state.

I mention these points because I have had considerable experience with water supply systems and have observed some peculiar things happening in connection with such work and, in finding out the seat of trouble, have generally found it to be due to a sudden fall or decrease of water at the source of supply. The diagram shows that the elevation from the outlet at the mill to the water level of the reservoir is about 41 ft. and that the pipe line is taken out from the reservoir at or very near the water line or same level. The diagram convinces me that the intake of the pipe line acts as a sort of overflow for the reservoir. If this is wrong, then he should have made his drawing show exactly how the outlet was designed.

If this water is received from springs or natural resources without the aid of pumping machinery, the cause of his trouble may be similar to what the writer has experienced at times, due to a sudden recession of the water level in the reservoir, which leaves the outlet unsubmerged and naturally causes a stoppage of flow through the line. If the reservoir is roofed in and the trouble had been this, Perplexed Engineer may have overlooked this seat of the trouble and started to take his pipe line apart. During the time he was taking this line apart and reassembling it, the water level may have risen enough to start the flow again and continued long enough to re-uncover the outlet, when the flow would again stop. If the general water supply in his territory has been anything like in the writer's, this could easily have happened, because there has been a severe shortage of water supply in some parts of the country this season and a very small stream would soon exhaust the supply so as to cause an intermittent flow of water.

The writer has seen numerous cases where the supply of reservoirs, especially of small capacity, was entirely exhausted during drouth periods when the demand for water was heavy. I have found the intakes completely uncovered and the pumps drawing air instead of water. If this is of any aid in Perplexed Engineer's case in solving his difficulty, I would suggest as a remedy that he lower his intake to or near the bottom of his reservoir and use a suitable screen on the intake so as to prevent foreign matter from entering and obstructing the flow of water through the line. Otherwise I can see no reason for the intermittent flow of water through the line as long as the intake was submerged and there was no obstruction in the line, as Perplexed Engineer stated. N. EWING.

Water Rates of Engines

WHAT MAY BE EXPECTED as the average water rates per horsepower hour of the following types of engines: Plain slow-speed noncondensing Corliss; four-valve; high-speed, noncondensing Corliss; high-speed, single valve noncondensing automatic; and plain throttling noncondensing slide valve? This is to apply to engines having ratings of from 150 to 200 hp.

2. Which is preferable, say, for example, in a high-speed direct-connected alternating-current unit of from 150 to 200 kv.a., a side crank engine or one of the center crank type? B. H.

ANSWERS

A PLAIN slow-speed Corliss engine running noncondensing requires about 25 to 27 lb. of water per horsepower hour, and 4-valve or high-speed Corliss noncondensing, 26 to 28 lb., a high-speed automatic single-valve noncondensing, 29 to 32 lb., and a plain slide-valve throttling engine running noncondensing, 46 to 48 lb. These figures are based on engines rated at about 200 hp.

2. In a high speed direct-connected unit we would prefer a center crank engine for the reason that the load on the bearings would be distributed equally between the two bearings which would not be the case in a side crank engine.

Of course, to a great extent, it is a matter of personal preference, as from a standpoint of efficiency, the side crank engine is no doubt equal to the center crank engine.

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What Becomes of Capital?

Because of the present attitude of some workers toward the "capitalist" who is by them alleged to give nothing in return for what he receives, it is worth while to think for a little of what makes a man a "capitalist" and what becomes of his capital.

If a man works only with his hands and owns nothing that in any way aids in his work, he may be classed as purely "labor." If, however, he owns a shovel, a pick, a saw, a wrench, which he uses in his work, he thereby becomes a "capitalist" to the extent that he gets more return for his work than he would if he did not own and use his tools. His wages become in part a return for his labor, and in part rent for his capital. He may go on acquiring capital in the form of tools or machinery or money and his income may depend to any degree in part on the return for labor and in part on the return from his capital, the capital being used by him, or rented out to others, in which case the return is known as interest or dividends. If he uses the capital himself, the return is called profits.

Now what does he do with his income? He may dispose of it in three ways: To buy things which he or his family will consume or use, such as food, fuel, clothing, a house and luxuries; second, he may hoard it in the form of money; third, he may invest it—in his own business for tools, machinery, buildings, raw material—or in some other industry, in which case he gets bonds or stocks to show how much he has invested and what return he is to receive. If he buys for consumption, or invests in business, he becomes an employer of labor, for statistics show that in either case 80 per cent of what he spends or invests will go to the worker. He is, therefore, contributing to the welfare of the community in either case. Only in case he hoards money is he depriving his fellows of all benefit from the income that he has received.

Evidently a man who works and also has investments in tools, machinery, buildings or raw material used by industry is a combination of laborer and capitalist. Only when he ceases to do any labor which contributes to the world's welfare does he become a pure capitalist; and it is evident that such men are very few in number.

To avoid becoming in any degree a capitalist, a man must avoid all investments. He must use up in his living all his income or must hoard his savings and deprive industry of their use, at the same time losing all return for himself on the savings. Such men, also, are very rare. Practically all who are classified as capitalists are laborers, and those who call themselves laborers are capitalists to some degree.

Is the capitalist part of a man to be condemned as an evil to society?

Census figures show that there has been a steady increase in the amount of capital invested per worker in industry; and that with this has come an increase to the worker in the return for his labor. Evidently, a man with a shovel and wheelbarrow can move more coal in a day than one working with his bare hands only. Carrying this on, the greater investment he has to help him in the way of cranes, conveyers, cars, etc., the more he can do and the better pay he can earn. But how shall this capital which is to be invested, be secured?

If a man hoards his savings and can safeguard them from theft, evidently he will always have them to spend when he wishes. If he puts them into industry, either for his own or somebody else to use, he may not be able to get them back instantly when wanted, and if he, or the man to whom he has loaned his savings, is unsuccessful, he may lose part or all of this capital. There must be some return adequate to get him to take these risks.

Some industries will carry little risk, some more. Evidently those which have the greater risk of loss must pay more for their capital, so that a fixed rate of return for the use of capital cannot be set. As a rule, also, the rate of wages is higher in those industries where the risk of loss is greater, so that it is an object to workers that investments be made in such industries, so that the workers may have the opportunity for better wages.

Now, if all return on capital is to be done away with, as advocated by some radicals of the Russian school, there will be no object for any man to invest his savings. In fact, he would be a fool to do it. He would, perhaps, save something from his wages until it became a bother to care for it or he feared that it would be stolen. Then he would either spend all he could earn, or work only enough to supply his needs. In one case, he becomes a spendthrift; in the other, a loafer.

Normally a man wants to lay by so that he may provide for his old age or for some desired gratification. It is reasonable and right that the return for his labor should enable him to do this, provided he is willing to return to society in productive work value for the wages that he receives. Society has not, however, a limitless store of money from which it can pay him wages, regardless of what he produces, and only as he does productive work has he any claim for wages. If, in his work, he uses his own or others' invested capital, thus increasing his production and his wages, it is fair that part of the value of this increased production should go to pay for the use of the capital. Any man can share in the returns on capital by saving and investing. The amount that he can save and invest will depend on the value of his work to society, and what he receives for that work. Few will argue that the worth of the work of a skilled engineer is no more than that of a man who breaks stones for a highway; or that the value of the work of the President of the United States is no greater than that of a time clerk in a factory. If a man is getting more wages than he earns—is receiving more than the value of what he produces—evidently his labor is overpaid, be he President or shoveler, and he is a burden on the world of industry. Such savings as he may accumulate are not fairly gained, and society might be justified in reclaiming the part that he has not earned, either by appropriation or by taxation.

But, even if he keeps these savings, what becomes of them? He will not be likely to hoard them; and if he invests them, they return to industry to help increase production and the wages received by workers. As already stated, 80 per cent of this increase goes, on the average, to workers, and 20 per cent to capital. Hence, the worker benefits 4 to 1 from these invested savings, as compared with the owner; and of the 20 per cent that goes to the so-called capitalists, only a small part is used y them for their living. What they do spend again goes out for the products of labor, of which the workers get 80 per cent; the balance is again returned to society as investment to create greater opportunity for employment in industry.

If all return to capital were abolished, the workers would get only the 20 per cent of the value which now goes to capital; the incentive to save and invest would be gone, and progress in industry would be blocked. For it is only by improvements in machinery and by increasing equipment that larger fields are opened for workers. The greater the part of the return from industry that is saved and invested, the more rapid will be the progress in industry, and the greater the returns to workers.

There is no royal road of ease to a competence and a comfortable old age. Wealth is produced only by labor. Savings, which invested become capital, are the result only of thrift. The remedy for industrial ills lies *not* in as short hours as possible, as little work as possible and a high rate of spending; but in a reasonable day of work, effort to produce as much as possible and to receive a right return for it, and saving and investing so as to accumulate capital as fast as possible.

The U. S. in 1920

WITHIN a few weeks, we shall enter a new year. What fortune has the coming year—1920—for the United States? What position shall we hold among the nations of the world; what will be our prestige as a people before 1920 draws to a close?

During most of 1919, we have been marking time, instead of marching. We have been trying to solve some of the more pressing problems growing out of the recent war. We have been talking a great deal about "reconstruction" and doing comparatively little reconstructing, either at home or abroad. Yet, under the surface of all our talking, it is possible that the germ of real action may have been gathering vitality and that presently we shall bring into full play our old traditions of activity and achievement and take the place that is rightfully ours among the world's nations.

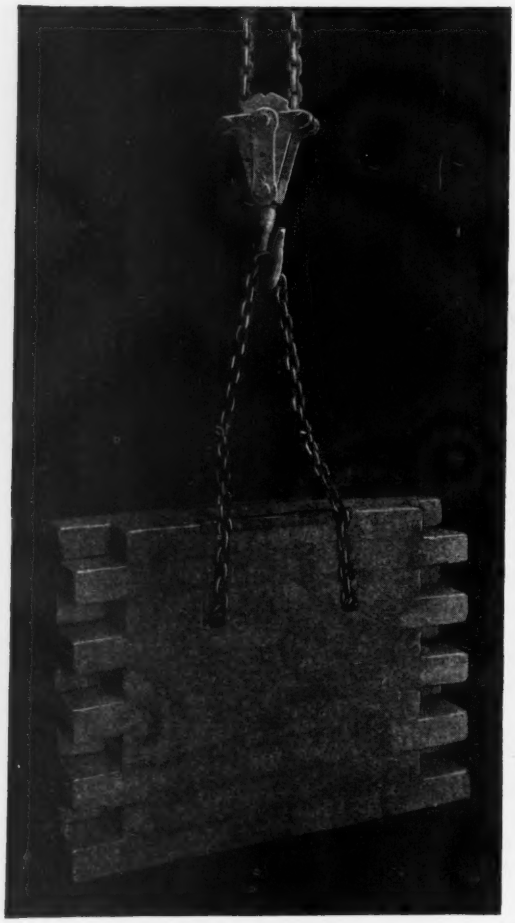
At least one may hope that, while 1920 is still young, the United States will have fully acknowledged the will of the vast majority of its citizens and have assumed officially and gladly all possible responsibility for conditions which we as a nation helped to create and which we as a nation must help to mold into forms consistent with our war-time ideals and our national traditions. This is a wish for the new year which every true American should express heartily and which every one of us should work with untiring zest to make effective.—The Valve World.

VIRTUALLY all the diseases affecting human beings reach the United States. Only one-half of those affecting animals prevail among us. While few human diseases are absolutely rooted out, several animal diseases have been completely overcome in this country and others are in a fair way toward eradication. The size and strength of men and women are about the same; but our cattle are steadily becoming larger, our horses stronger, our chickens handsomer and more productive of eggs. And the advance is not due to natural evolution but to artificial aids to nature.—The Nation's Business.

Interesting Test of Fire Brick Cement

FOR the purpose of demonstrating the air-set feature of a high temperature cement, the manufacturer has laid up a 9-in. section of wall containing 70 standard fire brick as shown in the illustration. In laying up the wall the bricks were first dipped in water and then the ends and one side were dipped in a batter of special cement. Bricks were squeezed together and tamped to insure a close fit and a strong, thin joint secured.

A reasonable time was allowed for the sample wall to set at atmospheric temperature, no heat being used to effect the bond. Holes were then drilled through the wall between the third and fourth courses from the top and bolts run through. To these bolts chain tackle for hoisting the wall section was attached.



PART OF FIRE BRICK WALL UNDER TEST

The mechanical strength of the air-set joint has been conclusively demonstrated by shipping the wall section hundreds of miles by motor truck for exhibition purposes at conventions where it has been suspended for inspection and it still remains intact.

Walls and arches of furnaces or boiler settings are often subject to similar, though less severe, mechanical strain on account of vibration due to adjacent machinery, or other conditions which tend to open the joint; resulting in cracks, a broken arch or bulging wall and the ultimate collapse of the furnace structure. Thus the need of a shock-proof as well as heat-proof joint can be fully realized.

While this test illustrated the fact that a bond is secured at normal atmospheric temperature through the entire thickness of both courses, the action of heat will merely strengthen the bond, which will retain its strength up to the fusing point of the brick itself.

The weight of the section shown is approximately 525 lb., of which 25 lb. represents the quantity of cement used.

Dead Gas Pockets

IN CONNECTION with their research and development work, the engineers of a mechanical soot cleaner manufacturer have brought to light some valuable and interesting information regarding the protection of soot cleaner elements by means of so-called "dead gas pockets."

Inasmuch as the temperature of combustion in a boiler furnace frequently reaches 2500 deg. F., it is evident that soot cleaner elements cannot be placed within the immediate zone of this high temperature. Protection of some kind against both convection and radiation is necessary, especially in steep tube boilers which require cleaner elements at the bottom and top of the first pass, where the temperature is usually high, whereas in the second and third pass it drops to a degree that does not influence the strength or properties of wrought iron or steel.

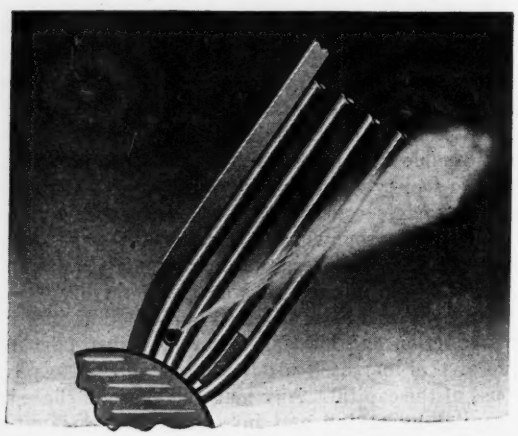


FIG. 1. LOCATION OF DEFLECTING BAFFLE TILE

As applied to horizontal water tube boilers the temperature problem is seldom serious because it is the usual practice to place the soot cleaner elements at the top of the tube bank where the temperature seldom if ever reaches 1000 deg. F.—a temperature that does not affect cast iron sheaths.

To protect fully the soot cleaner elements in steep tube boilers a deflecting baffle tile, or row of fire brick forming a pocket in which the element is operated is placed at the bottom of the first pass as shown in Fig. 1. This pocket eliminates the direct scrubbing action of the hot gases. Space is allowed at the bottom of this baffle through which soot and ash will drop during t

cleaning process. The cast-iron sheathing used for further covering and protecting this element is clearly illustrated in Fig. 2.

At the top of the first pass is another dead gas pocket in which is located the second soot cleaner element. This element, also, is further protected by means of the special cast-iron sheathing shown in Fig. 3. This second element rests upon the circulating tubes close to the front drum. Contact with the comparatively cool tubes assists greatly in maintaining the element at a safe temperature.

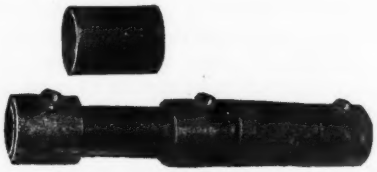


FIG. 2. CAST IRON SHEATHING FOR PROTECTING LOWER ELEMENT

By arching the baffle tile over the circulating tubes as shown, the hot gases, in their natural flow, do not come into direct contact with the element. The elements in both instances are placed in strategic and commanding positions, making it possible to clean easily what has heretofore been the most difficult and the most important portion of the boiler—the first pass. It is well known that in the steep tube type of boiler, most of the steam is generated in this pass, hence the importance of keeping the first pass well cleaned.

FIG. 3. LOCATION OF SOOT CLEANER AT TOP OF FIRST PASS

In boilers of this type where the tubes are arranged in squares, perpendicular nozzles are used as shown in Figs. 2 and 4; that is, the nozzle makes a right angle with the axis of the element, hence the jet is directed between the tubes. With a nozzle blowing into every space, rotation of each element in Figs. 1 and 3 through approximately 90 deg. thoroughly cleans the entire bank of tubes.

Experience has proved that burned furnace gases are oxidizing, hence there is little if any hazard in exposing bare elements to the low temperature gases. The high temperature problem is, as a rule, of greater importance than the corrosion problem; but this has been

FIG. 4. SHOWING CAST IRON PROTECTING SHEATH AND NOZZLES

effectively solved by these investigators by means of combined dead gas pocket protection, cast-iron sheaths, and contact with the comparatively cool boiler tubes.

Hints for Crane Operators

By Ray Cochran

IN practically all but the very smallest plants, electric cranes are now an integral part of the equipment installed; but despite this, little is seen in trade and technical publications regarding this important piece of apparatus. It appears therefore desirable to give at least a few hints relative to safe and proper operation of such cranes. I believe the following rules good for the crane man to follow:

See that all plate or clamp hooks are securely fastened and that there are no twisted links in the chain.

Never lift any object on the signal of two men. This may impel you to try to please both and still please neither.

Never carry a man on the hooks.

Always see you are as hook short as possible.

Do not attempt to make a lift when in doubt about signals.

Do not throw out your limit switch.

Go over the plate hook chains and clamp hooks at least three times each week and make sure they are in good condition.

Keep the compensators on your motors clean.

Go over the main cable once a month and note its condition. I have found it a good rule to measure off about a foot along the center of the cable and count the broken strands. If more than 20 are discovered, it is a good idea to replace the cable.

U. S. Civil Service Commission announces examinations for civil engineer and mechanical and electrical engineer. Vacancies in the Philippine Service, at salaries ranging from $2500 to $3000, and in positions requiring similar qualifications, will be filled from these examinations. Competitors will be rated on general and technical education, and preliminary or apprenticeship training, responsible experience and fitness, and must have reached their twenty-fifth but not their fortieth birthday on the date of making oath to the application, and must be physically qualified for performing the duties required in these positions. Apply for Form B. I. A. 2, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

According to a statement made by Peter C. Hewitt, of New York, talks with Europe by wireless telephone will be an ordinary event for American business men within 3 yr.

Boiler Repairs by Oxy-Acetylene Welding

By Mark Meredith

WITHIN recent years the practice of making good certain defects in steam boilers by means of oxy-acetylene welding has become very general, and repairs of a most varied nature are nowadays carried out in this way.

The varied forms of repair include the welding of fractures and grooves, reinforcing the landing edges of leaky riveted seams, which have become reduced as a result of repeated chippings and calking, thickening plates which have become reduced in thickness over small areas by corrosion, cutting out defective pieces of plate and welding in new pieces, etc. Now, while there can be no objection to the carrying out of certain repairs by oxy-acetylene welding process, it is a fact that there is a tendency to apply the process in many cases where it is quite unsuitable for the purpose.

Where parts are in compression, the pressure tends to close the surfaces together, so that even if the joint is not perfect, there is not the same risk of failure occurring. On the other hand, when the parts are in tension the pressure is constantly tending to open up the jointed surfaces and the slightest imperfection is therefore inadmissible.

In Lancashire and Cornish boilers the shell is in tension, while the furnace and flue tubes are in compression. Hence with such boilers it is, generally speaking, only defects which occur in the cylindrical tubes which ought to be made good by oxy-acetylene welding. Nevertheless it is a fact that defects in the shell are frequently "made up" in this way, particularly where second-hand boilers are concerned. Indeed the oxy-acetylene welding process has proved of great service to dealers in second-hand boilers, inasmuch as it not only enables them to get defects made good, but it furnishes a means for concealing defects, so that an intending purchaser is prevented from finding out that the boiler is in any way defective. For instance, a dealer in second-hand boilers purchases a boiler which has been on damp seatings for a number of years, and which has, in consequence, become more or less severely corroded along the surfaces of contact with the seating blocks.

Owing to the defective state of the shell, he is able to purchase the boiler at a comparatively low figure. If he is unscrupulous he will then have the corroded portions made up to the original thickness by oxy-acetylene welding, and if the work is neatly carried out, the fact that the boiler has been seriously corroded at the seatings may never be discovered. The broker may thus obtain a high price for a boiler which is quite unsuited for any really useful pressure. If, of course, the intending purchaser takes the precaution of having the boiler examined by a reliable insurance company before purchasing he is not likely to be "taken in" in the manner referred to, because an experienced inspector will generally find out the defective parts that have been made up by acetylene welding, whereas an ordinary engineer not trained in the work of boiler inspection would fail to do so.

In addition to having corroded shell plates thickened up, the unscrupulous dealers in second-hand boilers have been known to remove patches and replace these by new plates, carefully welded in by the oxy-acetylene process. It is well known that a boiler with any patches on whatever is unlikely to sell for a good price, hence the reason why an unscrupulous dealer will resort to the practice referred to, obviously a risky one, particularly where external shell plates are concerned.

As a general rule, the cutting out of defective portions of plate and substitution by welding in new pieces is inadmissible except in places where the plates are well stayed, as, for example, in the fire boxes of boilers of the locomotive type, and in the combustion chambers of marine boilers. In such cases the stays belonging to the defective plate will, of course, have to be removed with the plate and new stays afterwards fitted.

The oxy-acetylene flame may be used with advantage for cutting out defective portions of plate, as it effects the work rapidly and satisfactorily. The intense heat of the flame does not appear to leave any injurious effect upon the plate material beyond rendering the metal just at the edges somewhat hard. By taking off a thin chipping all round the hardened metal may all be removed.

The repair of fractures by the oxy-acetylene welding process requires considerable care, as otherwise the atomic forces of expansion and contraction will be brought into play with serious effect, giving rise to further fractures or extension of the fracture being required. It is important that a fairly large area of plate in the vicinity of the fracture be heated before the actual work of repair is commenced, the intensity of the heating being gradually tapered off toward the more remote portions of the plate. In the case of a fracture in a stayed portion of plate, as in a locomotive firebox or the combustion chamber of a marine boiler, the stays in the vicinity of the fracture will have to be removed before commencing the welding, so as to provide the required elasticity for taking up the movements of expansion and contraction which occur during the heating up the cooling down of the metal.

Experience seems to show that where old furnaces and flue tubes are concerned, attempts to repair fractures by the oxy-acetylene process often proved more or less unsatisfactory, since there is a tendency for further fracture to break out about the repaired portion in a short time after the boiler has been put to work. Hence, where extensive fractures in old furnaces are concerned, the advisability of making good the defect by oxy-acetylene welding is open to question.

Whether or not repairs effected by the oxy-acetylene welding process will prove satisfactory in different cases will always depend to a large extent on the men who carry out the work. These men, in addition to being boilermakers, should be specially trained in the work. To allow inexperienced men to carry out work is courting disaster.

When repairs have been extended, the boiler should be tested hydraulically to a pressure of not less than 1½ times the stipulated working pressure. This will serve to show in a large measure whether or not the work has been satisfactorily performed. An experienced man will also be able to form a good idea as to the efficiency of the work by hammer-testing the p[illegible]

The Effect of Vibration in Structures

FOUR years ago, the Aberthaw Construction Co. started an investigation on the vibration of buildings, particularly manufacturing buildings. The study was intended to cover not only the causes of vibration, but also the effects on the structure, on the machinery installed, on the health and well being of the workers, and on the quantity and quality of production.

A preliminary report was published in the fall of 1916; but our entry into the war, and the many new problems which that brought, put a summary stop to the work. It is now being taken up again with the idea of following it through to a point where a complete report can be published. The Aberthaw Construction Co. will therefore be glad to have engineers, manufacturers, and others having knowledge of the subject, or having had specific experiences which would throw light on any of its phases, communicate with the company at 27 School St., Boston.

The previous work on this problem showed a wide diversity of opinion on some of its angles. It also developed that there is very little quantitative information extant which can be relied upon as giving authoritative data. It is particularly desired, therefore, that information of this character, however limited in its application, may be made available for the study.

Book Reviews

MILLWRIGHTING, by James F. Hobart; second edition, revised and enlarged; 438 pages, cloth; New York; price, $4.

The art of millwrighting is distinctively a part of the power plant engineer's work. This is especially the case in the small and medium size plants, where the engineer may, in addition to running the plant, be required to care for much additional machinery and equipment in other parts of the building or factory than the engine room. When any new machinery is to be installed, the engineer is likely to be the man called upon to do it, or at least supervise the installation. Many of the ordinary millwrighting operations, such as lining up engines or mill shafting, re-babbiting bearings, come under the engineer's supervision at least.

These, and most, if not all of the other kinds of millwrighting work incidental to the erection and maintenance of industrial buildings and machinery have been described in this book by Mr. Hobart. The chief point of difference from the first edition is in the addition of a chapter of 48 pages on the installation of electric motors. Among the other 20 chapters the following may be mentioned: Factory Location; Laying out the Buildings; Erecting Building and Machinery Foundations; Erecting the Building; Roof Timbering and Trusses; Laying out Shafting; Putting Pulleys in Place; Belts and Belting; Babbiting, Scraping and Lubricating; Steam and Water Piping; Erecting Steam Engines; and Steam Boiler Setting.

IN THE CHEMISTRY DEPARTMENT of the Engineering Experiment Station of the University of Illinois, a thorough investigation has been made of the nature of the four sulphur compounds in coal, the quantity of each form present, and the change which characteristic forms undergo when the coal is allowed to stand or is subjected to coking.

The following methods were developed for the quantitative analysis of each form of sulphur:

(1) The sulphate sulphur was determined by extraction of the coal with dilute hydrochloric acid.

(2) The pyritic sulphur was determined by extraction of the coal with dilute nitric acid; it having been found that nitric acid of a certain dilution has a selective action on sulphur combined as iron pyrites.

(3) The resinic sulphur was determined by extraction of the coal with phenol.

(4) The humus sulphur was determined either by a direct method or by the difference between the sum of the other three forms and the total sulphur in the coal.

The devising of such methods of analysis has been much sought after in recent years by coal and coke investigators, but without satisfactory results up to the presnt time. The methods here proposed have been put to extended tests with exceedingly satisfactory results.

These investigations which were made by A. R. Powell with Professor S. W. Parr are published in Bulletin 111 of the Engineering Experiment Station.

Copies of Bulletin 111 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

News Notes

AT A MEETING of the Board of Directors of the Society for Electrical Development held at the Society's offices, in the Engineering Societies Building, New York City, on Nov. 11. W. W. Freeman was unanimously elected president of the organization succeeding Henry L. Doherty who has held that office since the founding of the Society nearly 6 yr. ago.

As president of the Union Gas & Electric Co. of Cincinnati, Mr. Freeman is well known to all branches of the electrical industry.

Being vice-chairman of the Public Policy Committee of the National Electrical Light Association, of which committee Mr. Freeman was chairman for a number of years, the new president brings to the Society a broad experience in dealing with matters pertaining to the relations between the great electricity consuming public and the people who produce and market the energy and the devices through which it is used.

Under the guidance of Mr. Doherty, its past president, the Society has done a big work in getting the various branches of the electrical industry together and advancing their united interests.

In addition to the election of Mr. Freeman as president, two new vice-presidents were also unanimously elected. Fred Bissell, of the F. Bissell Co., of Toledo, is widely known as a progressive member of the electrical jobbers' fraternity. James R. Strong of the Tucker Electrical Construction Co., of New York, stands high in the estimation of electrical contractors and dealers.

Charles L. Edgar, president of the Edison Electric Illuminating Co., of Boston, was appointed a director representing central station interests in place of E. N. Sanderson, resigned.

Arthur J. Binz, of Houston, Texas, newly elected

Jupiter of the Jovian Order, was appointed to the Board in place of L. O. Ripley.

J. E. Montague was elected chairman of the new Executive Committee, the other members being: W. W. Freeman, L. P. Sawyer, W. D. Steele, E. W. Rockafellow, J. R. Strong, Fred B. Adam and J. Robert Crouse.

THE NUMBER of graduate students registered in the College of Engineering of the University of Illinois on Nov. 1, 1919, is as follows: Architecture, 127; architectural engineering, 147; ceramic engineering, 47; civil engineering, 326; electrical engineering, 445; general engineering physics, 2; mechanical engineering, 515; mining engineering, 58; municipal and sanitary engineering, 11; railway engineering, 36—total, 1714.

U. S. CIVIL SERVICE COMMISSION announces an examination, Dec. 23, for mechanical engineer, qualified in internal-combustion engine work. Vacancies in the Bureau of Standards, Department of Commerce, at $3000 to $3600 and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from this examination. Both men and women, if qualified, may enter this examination, but appointing officers have the legal right to specify the sex desired in requesting certification of eligibles. For the existing vacancies male eligibles are desired. The duties of appointees will be to initiate and direct experimental research work in connection with development of gasoline engines, particularly high-speed aviation engines, with special reference to problems of carburetion and utilization of heavy fuels, indicator measurements, and radiator and cooling systems. Competitors will be rated on elementary engineering education, post-graduate work and general engineering experience, and publications or thesis on some phase of internal-combustion engine performance. Applicants must have graduated in mechanical engineering from a college or university of recognized standing. In addition, they must have had at least 10 yr. experience, subsequent to graduation, in actual practice of the profession of mechanical engineering or in teaching mechanical engineering in a college or university of recognized standing. At least 3 yr. of the required experience must have been in such a capacity as to demonstrate ability to meet and direct men. Ability to conduct independent research work must be proven by publications cited or thesis filed with the application. Apply for Form 2118, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Trade News

E. B. BADGER & SONS CO. of Boston, Mass., announces the opening of a Chicago office at 616 So. Michigan Av.

C. W. CROSS has been appointed by the Chicago Pneumatic Tool Co. as Manager of Western Railroad Sales, with headquarters at Fisher Building, Chicago.

THE FILES ENGINEERING CO., INC., 75 Westminster St., Providence, R. I., has issued a new bulletin describing the Files hand stoker and showing the new coking plate and sectional dump grate recently adapted.

F. W. SINRAM, president of the American Gear Manufacturers' Association, was elected president of The Van Dorn & Dutton Co., Cleveland, Ohio, at the last meeting of the board of directors. Mr. Sinram has been general manager of the company for several years.

Franklin Schneider was elected vice president at the same meeting. Mr. Schneider is not only well known among the gear manufacturers and users of the country, but also is president of The Van Dorn Electric Tool Co.

GEORGE M. BRILL announces that following an interruption of his consulting practice in Chicago, including two years of war work, he has resumed his practice in New York, occupying as temporary office room 2607, Singer Building; after May 1, 1920, Guaranty Fifth Avenue Building. He will continue to specialize in the engineering of industrial plants and processes, improvements in operation and financial investigations.

CHICAGO PNEUMATIC TOOL CO. reports orders booked during the month of October in excess of any previous month since the armistice. The same is true of its English and German subsidiaries.

While the German subsidiary was seized by German government and has been run under "compulsory administration" since the United States participation in the war, compulsory administration has now been abolished and management is being transferred back to the Chicago Pneumatic Tool Co. through the Courts of Commerce, according to cable reports just received from the company's representative now returning from Berlin. Reports show that the German company was well managed during the war and is now operating on a satisfactory basis. Arrangements have been made to increase production.

The Chicago office of the company announces the appointment of Nelson B. Gatch as district manager of sales, succeeding L. C. Sprague, with headquarters at 52 Vanderbilt Ave., New York City.

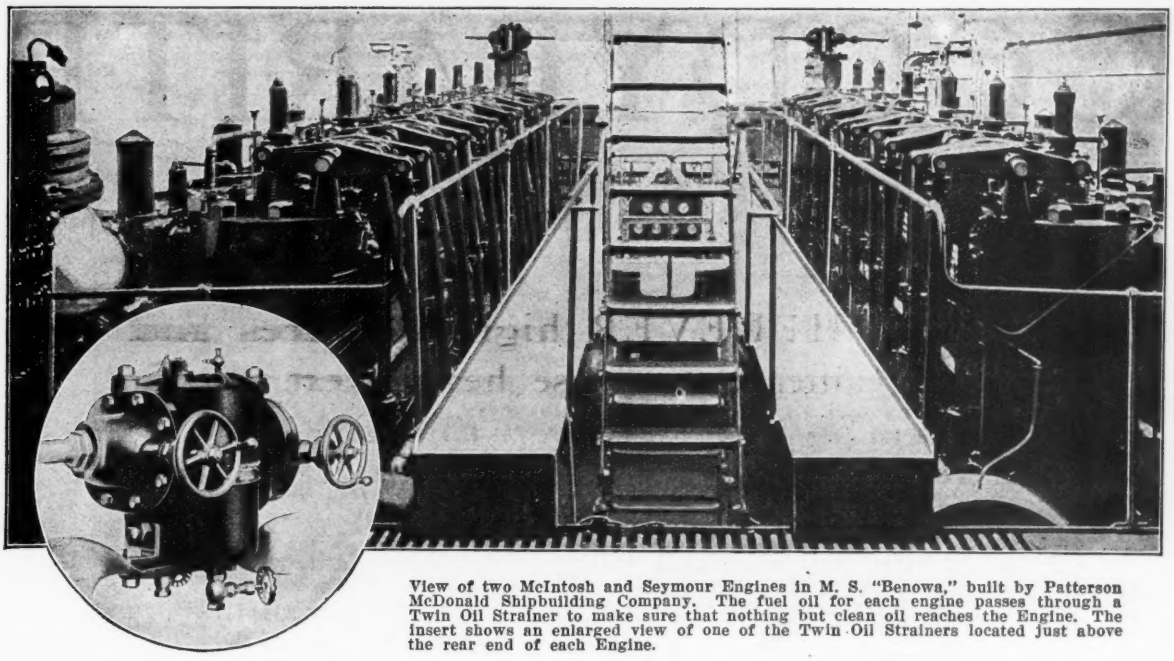
BULLETIN 1532-A describing in detail their line of Diesel type oil engines has been issued by the Allis-Chalmers Mfg. Co., Milwaukee, Wis.

E. B. BADGER & SONS CO., 63-75 Pitt Street, Boston, Mass., has recently issued a new catalog describing the firm's line of expansion joint.

THE FRANKLIN MFG. CO., Franklin, Pa., has just issued a catalog on heat insulations which contains brief and uncolored descriptions of packing and shipping data; engineering information; complete tables and data, concise instructions for their use, and concrete examples.

"A YARD of Installations," the latest folder of the American Steam Conveyor Corporation, Chicago, shows, in an attractive panel, views of installations of the American steam ash conveyor. This folder is being extensively distributed among power plant executives and is one of a series of pieces being issued.

BACHARACH INDUSTRIAL INSTRUMENT CO., 422 First Ave., Pittsburgh, Pa., has issued two new pamphlets. Pamphlet P summarizes the company's extended experience in the field of Pitot tubes and orifices; pamphlet F describes a new pressure-volume indicator, suitable for either permanent installations or testing purposes.



View of two McIntosh and Seymour Engines in M. S. "Benowa," built by Patterson McDonald Shipbuilding Company. The fuel oil for each engine passes through a Twin Oil Strainer to make sure that nothing but clean oil reaches the Engine. The insert shows an enlarged view of one of the Twin Oil Strainers located just above the rear end of each Engine.

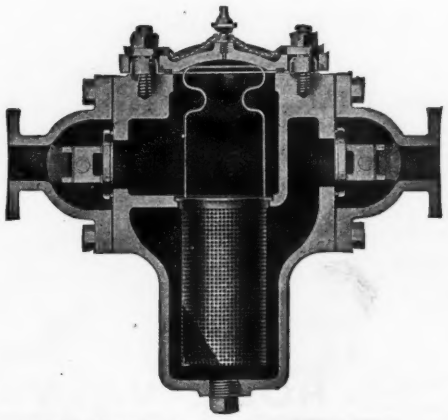
STRAIN Your Oil

Use Twin Oil Strainers and insure a continuous supply of clean oil. Sizes range from 1 to 5 inch. (2½ inch and larger sizes have flanged connections.) Basket mesh 1/64 inch or larger. Co nplete information in bulletin "AA" which will be sent on request.

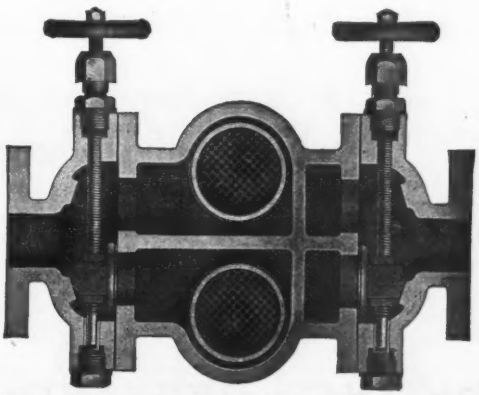
Fuel oils contain some solid matter which must be removed from them before they can be used with any degree of satisfaction either in an oil engine or in a burner under the boiler. To do this it is necessary to use some kind of strainer that can be cleaned without shutting off the supply.

The Twin Oil Strainer

gives the same service as two single strainers, but it is more convenient to operate, requires less space for installation and does away with extra valves and piping necessary to connect up. These are the features that lead to its being used in submarines and destroyers for the United States Navy, and in cargo boats for the United States Merchant Marine.



The oil enters the Strainer at the left and empties into and passes through the straining basket, then up and out at the right. All solid impurities are retained in the straining basket.



When a basket is clogged the valves are shifted to direct the flow of oil into the clean basket, which is in reserve. The compartment containing the dirty basket is then opened up, the basket removed, cleaned and replaced, and held in reserve until the basket then in service needs cleaning.

ELLIOTT COMPANY, 446 Fifth Ave., Pittsburgh, Pa.

GOODYEARITE

For the Main Head

WHEREVER high pressures and attendant intense heats exert terrific strain on packing, the very nature of Goodyearite guarantees reliable service.

Made of selected long-fibre rock asbestos, its tough strands compacted with the minimum amount of high grade rubber binder, this quality packing puts up lasting resistance to fierce temperatures and sustained pressures.

Goodyearite guards the entire line against blowouts—guards your time and power, your machines and your men. It holds up under the action of super-heated steam.

Where the conditions demand oil resistance—Goodyearite is the packing to use.

It lasts longer and costs less than packing which fails to give you this Goodyearite value.

THE GOODYEAR TIRE & RUBBER COMPANY
Offices Throughout the World

BELTING · PACKING HOSE · VALVES
GOODYEAR

In its swift, smooth gliding over the pulleys of this highly efficient Power Plant, Test Special Rubber Belting typifies inherent strength and dependability.

THE BELT FOR ENDURING SERVICE

On drives of the hardest kind everywhere—in Saw Mills, Paper Mills, Cement Plants, Machine Shops, Textile Mills, etc., Test Special Rubber Belting not only is performing faithful service, but is standing guard against costly shutdowns and delays. The friction surface affords the strongest pulley grip. The extreme flexibility permits the running over small pulleys at high speeds. The plies of cotton duck—of great tensile strength—are inseparably united by a tenacious rubber friction.

TEST SPECIAL RUBBER BELTING IS MADE TO SERVE YOU WELL

The New York Belting & Packing Co.

MAKERS OF BELTING SINCE 1846

BOSTON
CHICAGO
NEW YORK
PHILADELPHIA
PITTSBURGH
ST. LOUIS
SAN FRANCISCO

Does your packing lubricate?

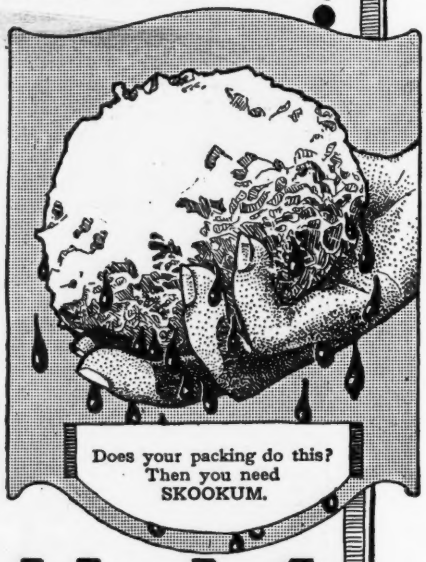
A good piston rod packing does not absorb oil like a sponge. Instead it feeds out the lubrication steadily and uniformly as needed.

How true this is of Skookum! The alternate layers of soft, pliable duck imbedded in tough, durable rubber serve as wicks for feeding out lubricating oil. The greater the gland pressure and expansion of the packing, the more rapid the flow of lubrication. The edges of the duck are exposed on all sides to facilitate the flow of oil.

Adequate lubrication and the sensitive response of Skookum to pressure eliminates loss due to friction. The diagonal cross-expansion quality gives Skookum maximum expansion and retraction.

Skookum is a one-piece, 100%-expansion piston rod packing. Wherever piston rod packing is used, it gives pre-eminent service. It is adaptable to *any* sort of pump or engine.

There's a test sample waiting for you—and it's *free!*



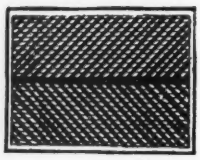
Does your packing do this? Then you need SKOOKUM.

PIONEER RUBBER MILLS
[Formerly BOWERS RUBBER WORKS] (5)
SAN FRANCISCO, U. S. A.

There's a distributor in your vicinity. SKOOKUM is sold in Canada as SPANDO

SKOOKUM

the ORIGINAL Diagonal Cross Expansion Piston Rod Packing



It Costs Nothing to Try

A cross section of "Herringbone" (Patented) expansion packing is shown above. Due to superior quality of materials and the patented stitch, "Herringbone" will give the superior service on high or low pressure steam, air, ammonia, acid, alkali or oil cylinders.

You are invited to try "Herringbone" on your worst rod—let us know the stuffing box dimensions and we will supply you.

IMPERIAL PACKING CORP'N
120 Liberty St., New York, N. Y.

1PC-8

HERRINGBONE
"PACKS RIGHT — STAYS TIGHT"
FIT FOR ANY ROD
PACKING

The Man "On the Job"

Won't you, during your shutting down time at the year's end, try good old EUREKA? All kinds of rods—good and bad—have been spending the holidays with EUREKA for nearly 35 years—think of it. A Happy New Year is bound to follow AS FAR AS PACKING WORRY GOES because, while rods change, EUREKA never does.

Do try EUREKA. We will gladly send you a free sample for a small rod. Doesn't it look good to you?

Eureka Packing Company
79-81 Murray Street New York, N. Y.

Any size valve packed from one spool by unstranding.

Avoid the Constant Repacking of Small Valves By Using

"PALMETTO" TWIST PACKING

TRADE MARK
REG. U.S. PAT. OFFICE

Its own lubricant keeps the stem so well lubricated that the hand wheel turns easily. Palmetto is heat resisting and the lubricant keeps it from hardening.

The amount of packing used to pack a valve is small, so that the expense of repacking is largely that of laoor.

It's Real Economy to use "Palmetto" Twist Packing

Braided round and square for rods.

Let us send you working samples to test—no charge.

For LOW PRESSURES below 100 pounds use "MANHATTAN" packing.

Greene, Tweed & Co.

Sole Manufacturers

109 Duane Street

New York

No! I Want TRADE DURACO MARK Packing!

Dealers are getting used to that phrase. Buyers know Duraco gives them service that excels any other packing.

Take **Duraco Sheet Packing,** for instance. No wires in it—just the best long-fibre asbestos obtainable. That gives it wonderful durability and immunity against heat and oil—an invaluable quality on gasoline motors. Cuts easily, and, having no wire, makes an even edged finished gasket. Cut as it is needed.

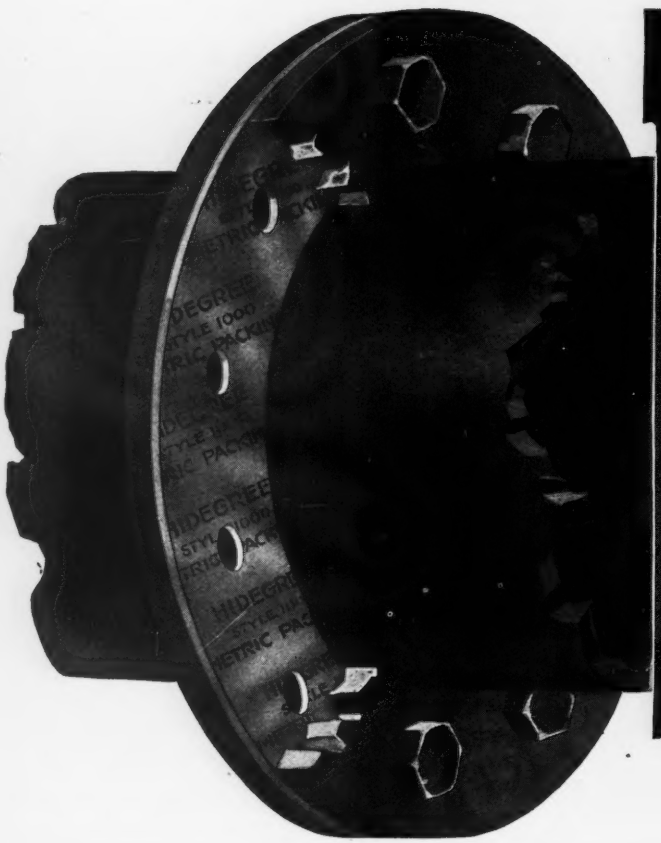
Duraco Graphite Asbestos Valve Stem Packing is another form—twisted or braided. Each strand of the asbestos yarn in it is thoroughly lubricated before being made up. It is waterproof, and doesn't become hard in service on water circulating pumps. Put up on spools—¼, ½ and 1 lb. each.

Duraco High Pressure Coil Packing is for steam and air service. Asbestos cloth in rolled block construction, with rubber cushion to resist high heat. Lubricated with high test oil and graphite compound.

Send for a small sample of sheet or enough for a small rod (give size) for test.

UNITED ASBESTOS & PACKING CO.

619-629 Washington Blvd., Chicago



HIDEGREE
SHEET PACKING

Will Stay Put
In Any Joint

against the most excessive pressures and temperatures of Steam, Air, Gas, Etc.

It has a tensile strength of over 6200 lbs., giving a factor of safety of about 30 to 1, and will stand the highest temperatures maintained in any plant.

Made in Sheets

1/32", 1/16", 3/32", 1/8" and 3/16" thick; 36" wide by 36", 72", 108" and 144" long; 50" wide by 50", 100" and 150" long.

A Trial Will Be Convincing

One of the Many Quality Packings Manufactured by

METRIC
PACKING CO. Inc.
BUFFALO, N.Y.
NEW YORK CITY, CLEVELAND, CHICAGO
SAN FRANCISCO, HAVANA
BUENOS AIRES

"FEDERALITE" Metallic Packing

FOR AMMONIA

FEDERALITE Metallic Packing has definitely proved its superiority for Ammonia Compressors. It is so constructed that *it wears longest* and *gives best service.*

FEDERALITE is made up of individual strands of composition metal each of which encloses strands of soft fibrous material. FEDERALITE is so made that every wearing surface is entirely metal—and a metal that *cannot score or injure your rods.*

FEDERALITE is favorably known to all manufacturers of Ammonia Compressors, and is used exclusively by many of them.

FEDERALITE SERVICE IS MEASURED IN YEARS. IT WILL INCREASE YOUR PLANT EFFICIENCY.

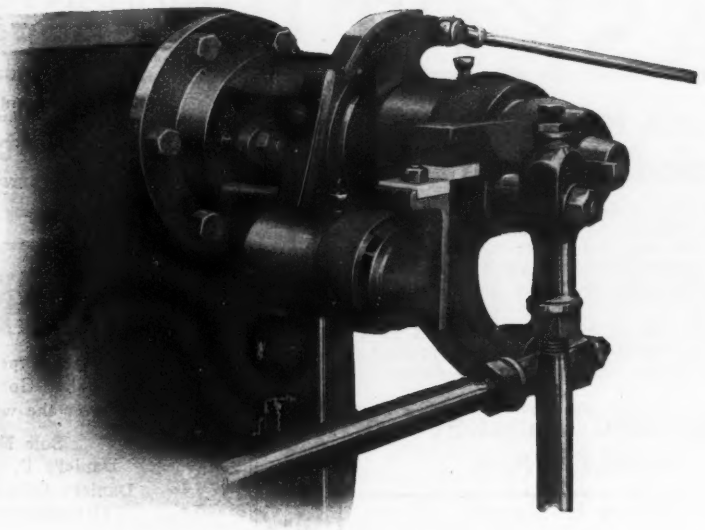
FEDERALITE Metallic Packing is also indispensable for Air Compressors, Superheated Steam, Centrifugal Pumps, Corliss and other Valve Stems, all classes of Steam service, and many types of Pumps.

FEDERALITE can be made the standard for your plant at a great reduction in your packing costs.

Federal Metallic Packing Co., 48 Hanover Street, Boston, Mass.

Manufacturers of Metallic Packing and Fibre Pump Valves

FLEXIBLE METALLIC PACKING



CORLISS VALVE STEMS

"JOHN CRANE" is an all metallic packing, made of thin babbitt ribbons, wound spirally layer upon layer with flake graphite between. It is flexible, compressible and is easily cut with a knife.

"JOHN CRANE" resists the constant steam temperatures so ruinous to fabric packings.

"JOHN CRANE" gives delicate operation without binding. It does not expand or contract and a perfect fit is the result.

"JOHN CRANE" gives additional bearing surface to the stems and is practically frictionless.

"JOHN CRANE" eliminates wear. Therefore the costs of expensive machining of the valve stems is avoided.

"JOHN CRANE" installations on Corliss valve stems can be counted by the thousands. Hundreds of installations over six years old.

CRANE PACKING COMPANY

General Offices: 1802 Cuyler Avenue, CHICAGO, ILL.

NEW YORK OFFICE - - 1536 Park Row Bldg.
HOUSTON OFFICE - - - 405 Scanlon Bldg.

CANADIAN FACTORY: WINDSOR, CANADA

Photograph of a ¼-in. Coil of "John Crane"

TRADE "Flexitallic" MARK

The Only

GASKET

Which takes care of Expansion and Contraction

Blow-Proof (Regardless of pressure or conditions). Especially recommended for boiler manholes, hand holes and tube caps for water tube boilers; also pipe flanges, super-heaters, steam hammers, etc., or any place impossible to hold tight with other gaskets.

"Flexitallic" is the only gasket you don't have to "follow-up." Circular and price list on request. Order through your dealer, jobber or direct.

"Flexitallic" Gasket Co.
CAMDEN, N. J.

EVERY ENGINEER
who cannot afford to lose his keys should have one of our Registered Key Rings. The best protection against loss. Write us and we will gladly issue one to you with our compliments.

"SAFETY" PLASTIC
METALLIC PACKING
FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903—Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS
WITHOUT RENEWAL

Drop us a line and let us tell you all about this remarkable packing

Steel Mill Packing Co. Established 1899 **Detroit, Mich.**
AGENTS WANTED

RUBBER GOODS

Over thirty years experience in the manufacture of Mechanical Rubber Goods. Our products are known and used all over the world.

Sole Manufacturers:
Daniel's P. P. P. Rod Packing
Daniel's EBONITE Sheet Packing
IRONSIDES Rubber Belting

QUAKER CITY RUBBER CO.
PHILADELPHIA, 629 Market St. CHICAGO, 182 W. Lake St.
PITTSBURGH, 211 Wood St. NEW YORK, 53 Murray St.

TRADE MARK HI REG U.S. PAT. OFF.

OHIO GREASE

The Paramount Lubricant

TRADE MARK HI REG U.S. PAT. OFF.

Sets a Supreme Standard by Which All Others Are Judged

The line includes a grease for every purpose, and its sure to be much better than you can buy elsewhere at any price. Let us send samples.

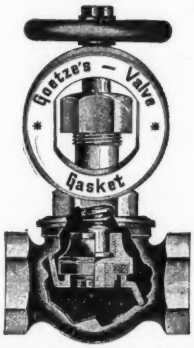
THE OHIO GREASE CO., Box 434, Loudonville, Ohio

Metallo Gaskets show the life and "comeback-ability" a gasket must have in order to make joints tight and keep them so. Try them for ninety days, and if they do not show these qualities and results, you may return them at our expense.

METALLO GASKET CO.
18 Bethany St., New Brunswick, N. J.

OVALHOLE
HOLLOW CENTER
PACKING
STOPS LEAKAGE

THE HOLLOW CENTER PACKING CO.
1276 West Third St., Cleveland, Ohio



In ordering please state whether Gasket is wanted with 2 flat sides inside, or with a round hole.

Goetze No. 2 Gasket for flange joints.

Tight Valves—With Good Discs

Good Discs should make valves tight and keep them so. A Valve Disc is rated by the **length** of the **dependable** service it gives and that is why

Goetze Valve Gaskets or Discs

are rated so high by engineers who, finding their valve troubles practically eliminated by their use, naturally insist that Goetze Discs shall be placed on all the valves of Jenkins or similar type in their plants. The copper shell and asbestos core have wonderful elasticity and hold effectively under the most extreme service conditions. They form a cushion for the valve seats which yields just enough to make the joint tight, but will not crumble or injure the valve seats in the least.

Goetze Valve Discs have always made good and they will make good with you. We shall be glad to send them on 90 days' trial. Give them the hardest work to do and they'll do it, or you may send them back to us at our expense.

We make the same trial offer on our

Goetze No. 2 Elastic Gaskets

the original corrugated metal-asbestos gasket, of which all others are merely imitations and generally poor ones at that. Simply cut out this advertisement and fill in the following. You will be glad you did it.

Send me on 90 days' trial, returnable at your expense,.....

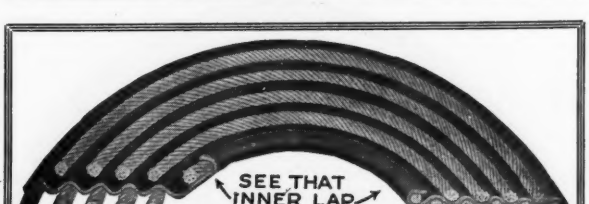
.....

.....

Goetze Gasket & Packing Company

17 Allen Avenue **New Brunswick, New Jersey**

Peter F. Daly, President. S. W. Conover, Vice-President and Treasurer.
W. Gierlich, Secretary and Manager.

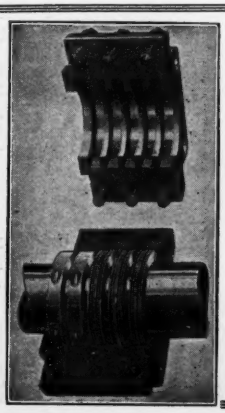


AKRON

Copper Asbestos Ribbed Gaskets with the Inner Lap

This is the best Copper and Asbestos Gasket made.
We also make all kinds of Metal Gaskets

Akron Metallic Gasket Co.
160 No. Union St., Akron, Ohio



No. 31-G—Gas Packing guaranteed against 1500 lbs. pressure. 2500° Fahr.

Tell us your Packing Troubles. We please others and can please you. Nothing too hard for us. 20 years experience—23 patents.

Holmes Metallic Packing Co.
Wilkes-Barre, Pa.

Ask for "Holmes" Pkgs.

The largest plant devoted exclusively to Metallic Packing in the world

He's Proud of His Pal—

—AMBEST—

The lubricated metallic packing that stands up to the most severe tests on steam, oil, ammonia, air, low or high temperature, superheated steam, where **the rod is true and in line.** The long, pliable strands of lubricated non-friction metal are easily separated to size needed and quickly inserted into a stuffing box.

Permanent, satisfactory service is assured wherever AMBEST is put on the job.

Self-lubricating, pliable indefinitely, AMBBEST will not scratch, score, bind, fuse or harden.

Thousands of engineers have corrected their packing difficulties by first writing for our literature and sample, and then ordering "AMBEST." Make AMBEST a pal of yours.

EUREKA PACKING CO.

79-81 Murray Street **New York, N. Y.**

SUPERLA BRAND

Represents New Process Friction Reducing Oils

SUPERLA
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OIL

CYLINDER
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TURBINE
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TRANSFORMER

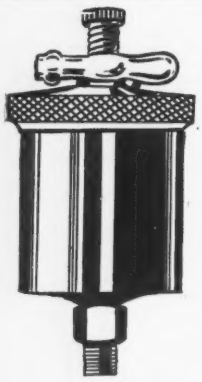
EVERY DROP COUNTS

Superla Brand Oils assure the highest degree of lubrication at minimum cost. Their adoption by leading industrial works of the world is the strongest proof of superior lubricating value and power saving properties

SOLE MANUFACTURERS

STANDARD OIL COMPANY

(AN INDIANA CORPORATION)



Fill Grease Cups only 1/3 as often

WHEN you fill them with NON-FLUID OIL which feeds slowly to bearings without waste, resisting the heaviest bearing pressure.

Each filling of

TRADE MARK REGISTERED IN UNITED STATES PATENT OFFICE
NON-FLUID OIL

lasts three to five times as long as ordinary cup grease.

NON-FLUID OIL is made of the finest mineral oil and contains none of the non-lubricating materials used to "body" common cup grease.

Use NON-FLUID OIL on all bearings of engines or machinery equipped with compression cups or designed for grease lubrication. There are special grades to take the place of fluid oil, too. Testing samples sent on request. Write today.

New York & New Jersey Lubricant Co.
165 Broadway, New York

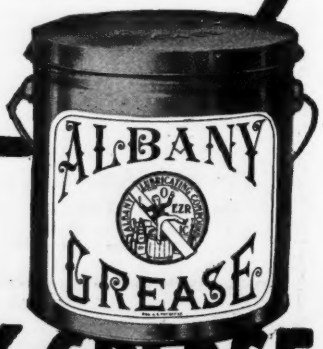
FOR MORE THAN 51 YEARS

Albany Grease has given a lubrication service of the highest type. Its incomparable record during the past 51 years stamps it as a most efficient and economical lubricant. That the fine lubricating qualities of Albany Grease have been appreciated is evident by the fact that more of it is used today than ever. Use Albany Grease on every bearing in your plant.

Samples will be gladly sent upon request.

Your Dealer Sells Albany Grease

ADAM COOK'S SONS, Inc.
708-710 WASHINGTON ST., NEW YORK
Established 1868



ALBANY GREASE

Lubricants that bear this Mark

are dependable and economical

That is why the barrel with the Texaco Red Star and Green T label is seen in so many of the best run power plants.

Under this mark you can safely purchase lubricants for all types of units, auxiliaries, or machines.

There is a Texaco Lubricant

for *Every* Purpose

Texaco Lubrication Engineers will gladly assist you in the selection of ubricants to economically and efficiently meet all your mechanical conditions.

Let them give you the benefit of their experience in power plants and shops of all kinds in all parts of the country.

TEXACO FUEL OIL
in various grades suitable for
use under Boilers, Forging, Annealing and **Heat Treating**
—Can be Secured in the territory East of the Rocky Mountains

THE TEXAS COMPANY

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HOUSTON CHICAGO NEW YORK

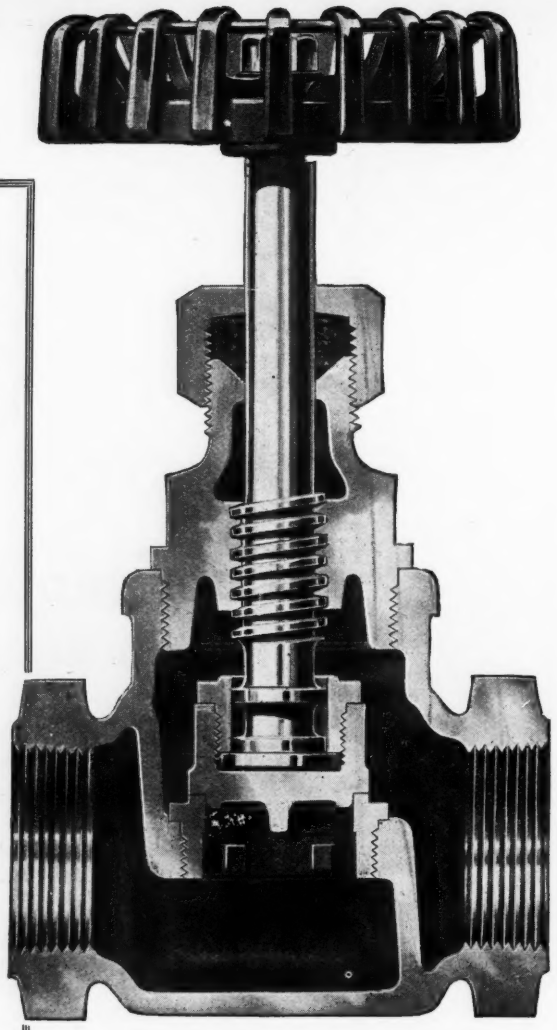
Offices in principal cities

The

HANCOCK Valve

with Renewable nickel seat and disc

—the valve without a peer



No other valve made begins to approach the efficiency of Hancock.

Conditions being equal no other valve made possesses the durability of Hancock.

Hancock superiority shows to best advantage where temperatures and pressures are extremely high.

Hancock Valves make good, regardless of the severity of conditions; first, because they are designed right, and second because both materials and workmanship entering into their construction know no equal.

Note these three characteristics of the Hancock Valve illustrated:

1. The cylindrical form of body—an exclusive feature which gives the valve great strength, and permits extra large areas through seat and body which practically eliminates friction.
2. The Disc is made of extremely hard nickel composition which will resist the cutting action of steam at pressures and temperatures considerably above those at which the corresponding part in other valves fail. The projecting lip on disc enters opening through the seat before valve is entirely closed, deflecting steam or other pressure medium so that seat surfaces are thoroughly cleaned before the seats come together.
3. The Renewable Nickel Seat possesses remarkable wearing qualities. The narrow flat seat will stay tight much longer than the forms of seats common to other valves. Two lugs projecting from lower part of seat allow the seat to be easily removed when renewal is necessary.

Hancock Valves are guaranteed to live up to every claim made for them. New descriptive and illustrated catalog will be mailed upon request.

Hancock Inspirator Co.

Sales Dept. of

Manning, Maxwell & Moore, Inc.

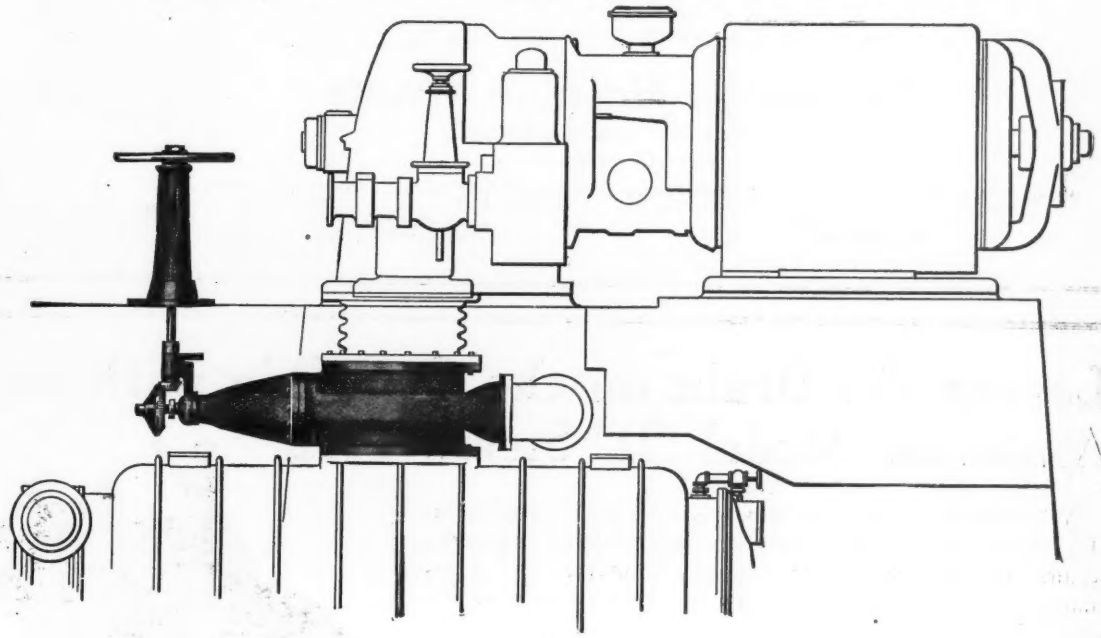
119 West 40th Street New York

Rice Building, Boston 29 N. Jefferson St., Chicago

Mr. Engineer—

Get the Blueprints on this Valve

THIS is our special **Chapman Turbine Exhaust Gate Valve** with Special Outlet for Atmospheric Relief. It serves the purpose of the gate valve and the T. This arrangement will reduce the depth of basement required by the installation of condenser. Probably you have been looking for just such a valve to help you solve some of your problems.



This coupon may be the means of providing you with valuable information. May we send you additional data, including dimensions? If so, use the coupon.

The Chapman Valve Mfg. Co.

Indian Orchard, Mass.

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Richardson Freres, represented by Charles Rigeaux, 109 Rue de Rome, Paris, France.
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Crosby Valve & Engineering Co., London, England.
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Smith-Booth-Usher, Los Angeles, Cal., representing Chapman Valve Mfg. Co. in Southern California, Nevada and Arizona.

The Chapman Valve Mfg. Co.,
Indian Orchard, Mass.

Please send me the data referred to on your Chapman Turbine Exhaust Gate Valve.

Name.....

Address.....

THE

Armstrong Steam Trap

SIMPLICITY

The outward simplicity of the Armstrong Trap is indicative of its simplicity in operation. Numerous bolts, gaskets, air reliefs and guages are unnecessary.

THE INVERTED BUCKET PRINCIPLE

eliminates air binding, frequent cleaning and repairing. The trap operates continuously for long periods without attention.

Put an Armstrong Trap on in place of your most troublesome trap. If it does not do business, return it. We will pay all charges.

OUR CATALOG WILL INTEREST YOU, SEND FOR IT

Armstrong Machine Works

310 Maple St., Three Rivers, Mich.

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Faget Engineering Co. San Francisco, Cal.

Lessen the Drain on the Coal Pile with an Anderson Model "D" Steam Trap

When steam is wet the fireman is kept busy. Wet steam also works havoc with engines, causing breakage and costly repairs, besides the loss resulting from shutdowns. Every added per cent of moisture in steam is a drain on the coal pile.

But when the condensate is efficiently drained from the lines steam will be dry. That is why the **Anderson Model "D" Steam Trap** is regarded by engineers as a great factor in plant economy as well as efficiency. A glance at the gauge glass is sufficient to show that the trap is working properly. Any foreign matter that may be in the condensate is caught in the removable strainer. The float is non-collapsible and is spun from high-grade copper.

The valve of the Anderson is at all times sealed by at least 3 inches of water—no chance for steam to escape and cause wire drawing.

Our free Catalog gives a full description of this wonderful steam trap. Write for it.

The V. D. Anderson Company, 1937 West 96th Street, Cleveland, Ohio

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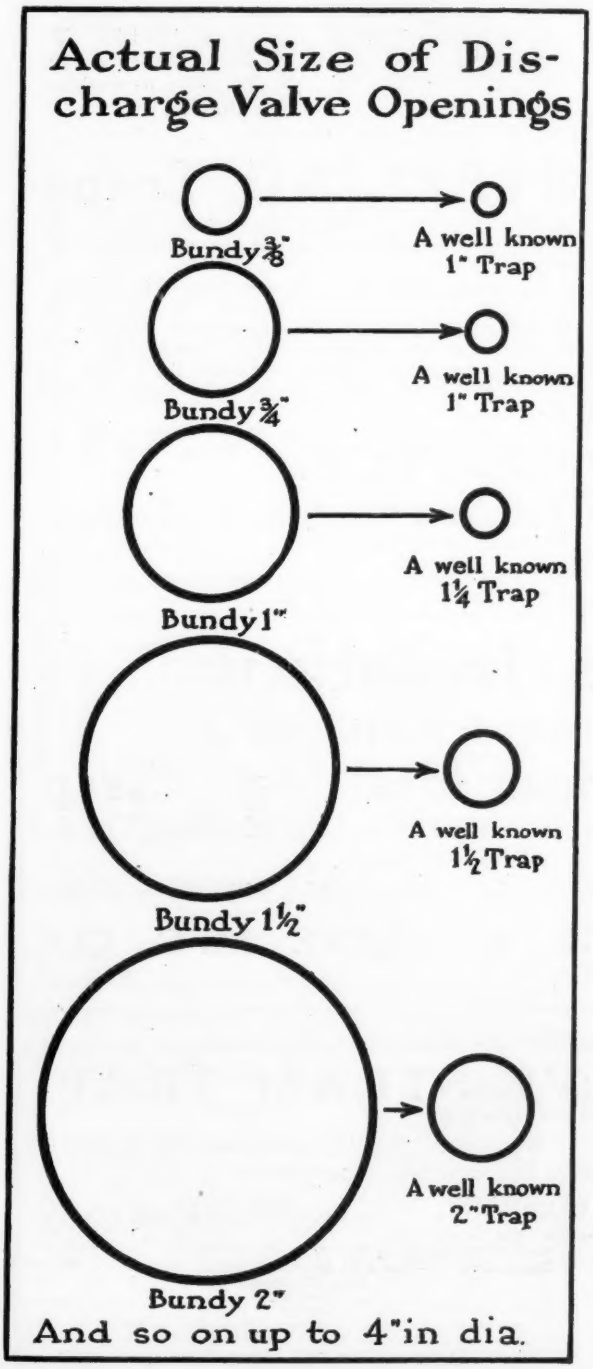
Why Buy Two or More Steam Traps When One Bundy Trap Will Do the Work


Actual Size of Discharge Valve Openings
Bundy 3/8"
A well known 1" Trap
Bundy 3/4"
A well known 1" Trap
Bundy 1"
A well known 1¼ Trap
Bundy 1½"
A well known 1½ Trap
Bundy 2"
A well known 2" Trap
And so on up to 4" in dia.

as well or better, for a long time and with practically no attention or repair costs? Is that economy? Is it good business?

The Bundy way not only costs less to begin with, but is infinitely cheaper by the year.

It costs less to begin with because

The BUNDY Trap Has From 2 to 10 Times the Capacity of Most Other Traps

of similar ratings, as shown by the diagram at the left, and it costs but little if any more than the best of others.

In other words, it will take at least two of most the other traps to give you the actual discharge capacity of **one Bundy** Trap at the same rated capacity. The difference is that the Bundy has **full openings**—on reduced areas to cut down capacity. The Bundy **printed ratings** represent **actual capacities.**

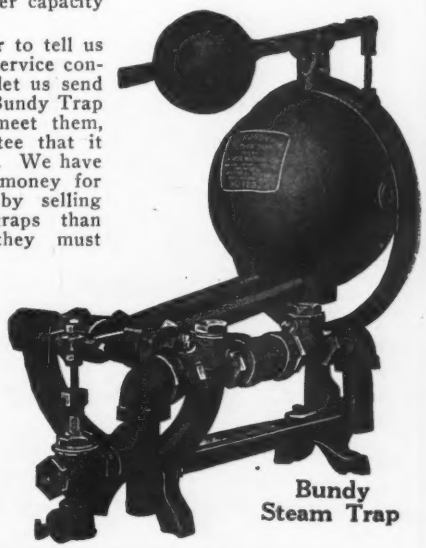
And that is the thing that makes price comparisons absolutely useless where the Bundy is involved, entirely aside from the consideration of superior quality and design. Accustomed to other trap ratings, you think to replace, say, a one-inch trap of another make with a Bundy one-inch Trap. You find the Bundy price somewhat higher. As a matter of fact, and as you will see by the accompanying diagram, a Bundy Trap of three-eighths-inch capacity has several times the actual discharge capacity of a trap of well known make rated at **one-inch.**

That's why we ask you not to order your Bundy Traps by rated capacity unless you are a Bundy user and know how much greater capacity they have.

It is far better to tell us just what your service conditions are and let us send you the size of Bundy Trap that will best meet them, under a guarantee that it will do the work. We have saved a lot of money for our customers by selling them smaller traps than they thought they must have.

That's only one of many ways in which Bundy Service helps Bundy users. Test it at our risk.

Ask for Bundy Trap Book "E," and our leaflet —"Bundy," the Factory - Tested Trap.



Bundy Steam Trap

Nashua Machine Company

103 N. Main Street, Nashua, N. H.
Frank H. Devine, New York Representative,
150 Nassau Street, New York

KIELEY

Steam
Water
Air

Specialties are the Auxiliaries of Economy

in the power plants which are daily paying dividends in fuel, labor and upkeep saved.

Kieley Steam Trap

KIELEY Steam Trap

—the old, reliable leader of the Kieley line, has given such superior service that engineers everywhere call for other equally efficient **Kieley** products. Better find out **why.** Write for catalogue.

KIELEY & MUELLER, Inc.

34 West 13th St., New York, N. Y.

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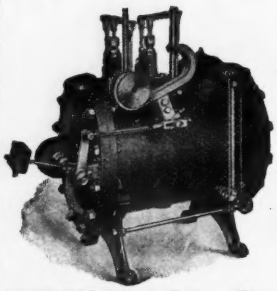
Simple and Durable



STERLING Direct Return Trap

You see all there is about this trap except the **STERLING** Indestructible Copper Float, guaranteed up to 300 lb. pressure.

That's inside. All other mechanism is outside where its working is visible.

STERLING Traps

handles **all** the condensate problems from collection to return to **any** boilers at **almost** the temperature received.

The **STERLING Direct Return Trap** is frictionless. There are no joints to be packed. It operates on **90 per cent less steam** than a steam pump. Steam used helps to increase temperature of the condensate.

Gauge glasses on all Sterlings show the amount of condensate in the traps and also its removal on each discharge.

Our literature fully describes the construction of **STERLING Steam Traps** and **STERLING Direct Return Traps.** Write for it.

Templeton Manufacturing Company

Charles River Parkway **Cambridge, Mass.**

Be Insistent

Standardize in your plant with

The American Ideal Steam Trap

LEAK-PROOF — POWERFUL — LARGE CAPACITY
ECONOMICAL

Helps to lower coal bills. Our booklet will help you—free

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York Chicago BOSTON Atlanta Pittsburgh

THE CORLISS VALVE STEAM TRAP

AND OTHER POWER PLANT EQUIPMENT

Atlas Reducing Valves and other Regulating Devices **Pumps, Air Compressors, etc.**

SEE SWEET'S CATALOG PAGE 543 AND CHEMICAL ENGINEERING CATALOG PAGE 795

PLANT ENGINEERING & EQUIPMENT COMPANY, HOME OFFICE: 192 BROADWAY, NEW YORK CITY

Write to or call on nearest branch office to save time

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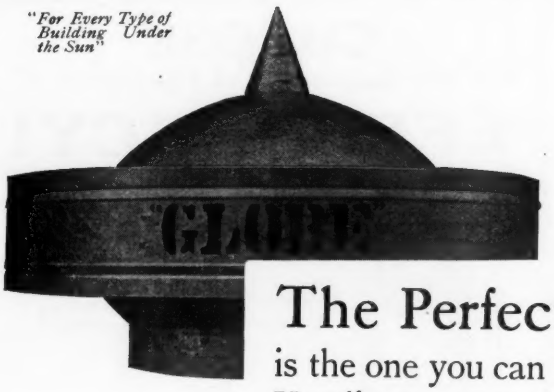
"For Every Type of Building Under the Sun"



The Perfect System of Ventilation

is the one you can install and FORGET—"GLOBE" Ventilators once installed require NO ATTENTION.

Nothing moves but the air—there is nothing that can get out of order or cause trouble. They are so durable they will last as long as the building itself if you have them painted when you paint the building.

"GLOBE" Ventilators operate perfectly in a 3-mile-an-hour-breeze and are suited for either flat or sloping roofs.

For complete information see Sweet's Catalogue Page 322 or write direct to Department B.

GLOBE VENTILATOR COMPANY, TROY, N. Y.

KEYSTONE TRADE MARK Reg. U.S. Pat. Off. GREASE

Makes the most efficient equipment more efficient

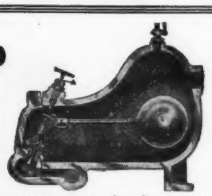
The Keystone Lubricating Co.

Executive Office and Works:
PHILADELPHIA, PA.

Established 1884 Branches in Principal Cities

McDaniel Steam Trap

for High or Low Pressure



The Trap that holds the Steam and removes all condensation from the steam pipes, steam cylinders, steam coils, jacketed kettles, steam separators, heating coils, and, in fact, at any point where water of condensation will collect. Steam can't blow through, they have large discharge valves and cannot be flooded with sudden flushes of water. Send for our yellow booklet that will tell you more about the Trap, or better still, let us send you one on 30 days' trial and you can see what a steam saver this Trap is. They pay for themselves.

Watson & McDaniel Co., 148 N. 7th St. **Philadelphia, Pa.**

Reliance Steam Specialties

WORKING PARTS of the Reliance Safety Water Column are Simple

The Floats are Reliance Seamless, each tested under 300 lbs steam pressure.

We also make
RELIANCE STEAM TRAPS
RELIANCE SEAMLESS FLOATS
CLEVELAND CLUTCHES

SPECIFY "RELIANCE"

Write for Information

Reliance Gauge Column Co.
5932 Carnegie Ave.
CLEVELAND, OHIO

The WYOMING AUTOMATIC ELIMINATOR

Takes Care of Slugs and Floods *Instantly*

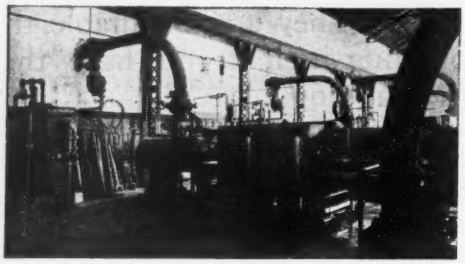
The Wyoming eliminates all water from steam—that's why we called it an *Eliminator*. The separated water immediately falls to a trap section below and is passed out through an outlet valve large enough to take care of all slugs or floods instantly—no chance for it to back into the cylinder and crack the head or break the piston. The outlet valves in other traps can be no larger than their floats will lift. In the Wyoming the valve is operated by steam. It is two or three times the size of the outlet valves in other traps.

We can ship Wyoming Automatic Eliminators promptly in sizes from 2 1/2 to 16 inches, and we would like to send you one on 30 days' trial. If it falls down—fails to make your steam 99.5% dry—ship it back collect.

We have a book on Eliminators that's chock-full of profitable information—prices, sizes, descriptions, etc., of both horizontal and vertical Eliminators. Your name and address on a post card will bring it.

W. H. NICHOLSON & CO.

120 Oregon Street, Wilkes-Barre, Pa.



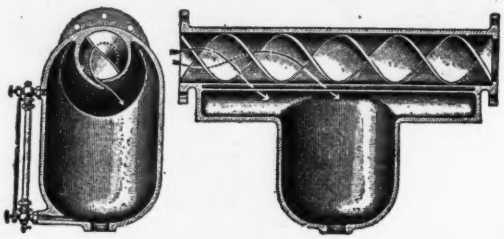
Three 10 inch Wyoming Automatic Eliminators protecting generator engines of a street railway company.

CHOOSE

Your Separator from the Standpoint of

EFFICIENCY!

"The Whirl and the Edge does it"



For separating water or oil from live steam, exhaust steam, compressed air, ammonia and other gases.

THE MOSHER SEPARATOR

is made in all sizes and for all pressures. Results guaranteed! For literature and list of installations address

United Machine and Mfg. Co.

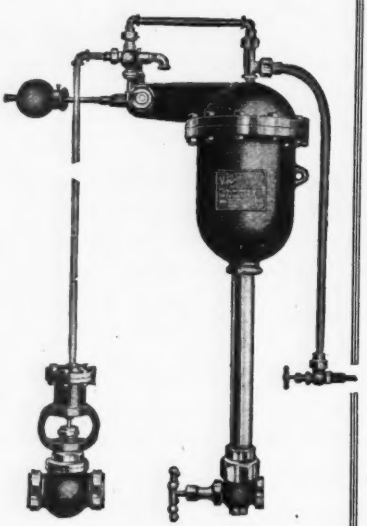
Canton, Ohio

(*Established Agents Wanted*)

A Feed Water Regulator

THAT OPERATES FOR 20 YEARS AND STILL GIVES SATISFACTORY SERVICE MUST BE ALL RIGHT

Many Vigilant regulators installed that long ago are still in service and giving accurate results. The principle on which the Vigilant is built is correct. It is a rare example of simplicity combined with complete efficiency. It positively regulates the water, keeping the waterline in the boiler uniformly at center-gauge.



Let us send you a Catalog, describing fully its construction and operation and then take advantage of the fact that the Vigilant is sent on 60 days' free trial.

Investigate.

Write us today.

The Chaplin-Fulton Mfg. Co.

42 Penn Ave., Pittsburgh, Pa.

Also Manufacturers of the Fulton Pump Governor

The Squires

Boiler Feed Water Controller

Trade Mark Reg. U. S. Patent Office

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Agencies in All Principal Cities

THE C. E. SQUIRES COMPANY

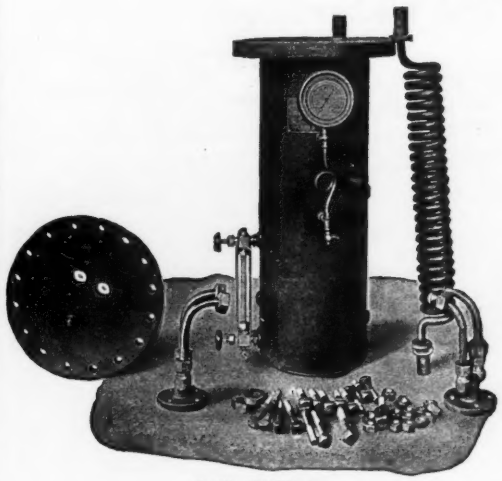
East 40th St. and Kelley Ave. Cleveland, Ohio

4,030,000 Boiler Horse Power

served by

Fuel Oil Heaters of our Manufacture

This refers to units in actual operation or now on order and being built in our works. For U. S. Navy, Merchant Marine and Stationary Power Plants



Reilly Oil Heater

ADVANTAGES

1. No internal oil joints—no possibility of contamination of high pressure steam through leaky oil joints.
2. Condensed high pressure steam used as the heating medium can be returned to boiler without danger of oil contamination.
3. Compact small space occupied.
4. External joint feature our exclusive patent.
5. All coils standard—Interchangeable construction.

Send for Bulletin No. 250

The Griscom-Russell Co.

2141 West St. Building, New York

Boston Pittsburgh San Francisco
Philadelphia Chicago

Strong Separators

Oil or Steam

Adaptable for either high pressure of exhaust steam. A special provision removes condensate or precipitation and deflects it to a water chamber out of contact with the steam current.

The separator consists of two parts —an upper or lower chamber. In the lower the water is collected.

Upon entrance to the upper chamber a violent centrifugal motion is imparted to the steam. This throws it against a perforated copper sheet. Entrained water passes through this but cannot pass back, and falls into the lower chamber. The result is **dry steam.**

Strong Separators are built in both vertical and horizontal types, and, with some slight modifications, the principle of operation is the same in both.

Made in sizes from 2 to 10 in., inclusive, even sizes only.

Fully described in our Catalogue T-30. Write for a copy.

The Strong, Carlisle & Hammond Co.

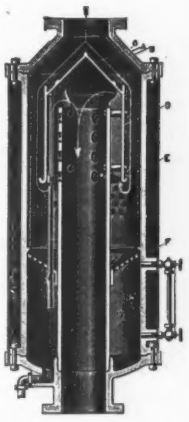
Cleveland, Ohio

Condensation's Doom

There is no room for condensation if a Sweet's Steam Separator is installed in your plant. It can be placed very close to the engine, allowing only dry steam to be delivered, thus avoiding accidents and large coal bills. It saves cylinders, valves and other parts from damage which frequently comes when steam is wet.

SWEET'S

Steam Separators



deliver steam 99.8 per cent dry, which is as near dry as it is possible for steam to be.

Your engine will give much better service. There are no complicated parts to get out of order and there is only one cost —the first.

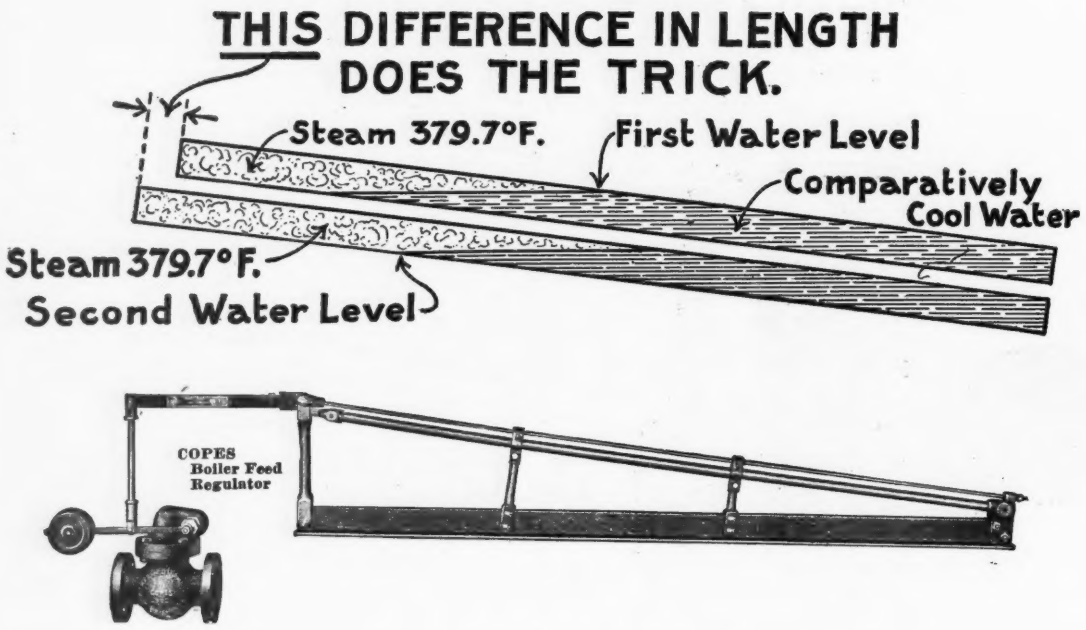
Write for our catalog which will help you to see why more than 50 per cent of our sales have been repeat orders.

The Direct Separator Company

Also Makers of Good Exhaust Heads and Flanged Fittings

820 Geddes Street Syracuse, N. Y.

HOW THE COPES WORKS



The above drawings show clearly how the Copes Boiler Feed Regulator works. We have purposely exaggerated the dimensions to make things clear.

The thermostat is simply a piece of heavy metallic tubing which generally inclines as indicated. The top is connected to the steam chamber of the boiler. The bottom is connected to the water portion of the boiler. Thus the water level in the thermostat varies with that in the boiler.

When the water level is high, as indicated by the words "First Water Level," the major portion of the thermostat is filled with comparatively cool water. The upper part is full of hot steam. This combination gives a definite length of tube and a definite valve setting.

Now let us suppose that a heavy peak load causes the water to drop to the "Second Water Level." The increased heated portion then naturally increases the length of the thermostat and we have another definite valve setting.

This continual expansion and contraction caused by the raising and lowering water level give the Copes its SCIENTIFIC feed. The photo of the Regulator shows distinctly how the connecting links transmit the force produced.

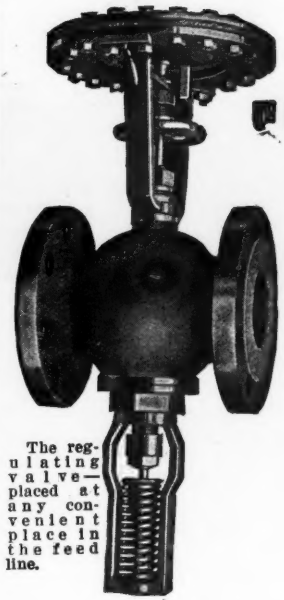
That's all there is to it. The Copes is the simplest of all regulators and it is the only regulator that controls SCIENTIFICALLY. IT DECREASES the rate of feed with sudden peak load, and INCREASES the rate with low load. At the same time, it feeds CONTINUOUSLY. Where load is constant, of course, it maintains a CONSTANT level. The fact that practically all the big central stations in the United States use Copes, and in view of the fact that these stations make careful research before purchasing, investigating and comparing with other methods, there can be no question as to the efficiency, safety, dependability, etc., of the Copes.

Direct. Positive. No springs. No pilot valves. No diaphragms. No boiling liquids or delicate parts to give trouble. No adjustments or repairs are required after the Copes regulators are cut into service. Reliable. Steady. Safe.

COPES
Boiler Feed Regulators

NORTHERN EQUIPMENT CO.
113 West 11th Street. ERIE, PENN.

Now is the Time to Remember the "S-C" is the



The regulating valve—placed at any convenient place in the feed line.

"S-C" SAVES COAL

Feed Water Regulator

Requires no expensive alterations in your present water column arrangement.

Generating unit connected to valve by seamless tube, and sealed into a "Self-Contained" system—cannot get out of order.

"It is a condition which confronts us—not a theory."

When Grover Cleveland wrote the foregoing famous sentence in his annual message of 1887 to Congress he had no vision of the coal situation as it exists today.

It applies as strongly as if expressly written for it.

Fortunate the power plant that can get coal enough to run on! Thrice fortunate if it has the **"S-C" Feed Water Regulator** installed on its boilers, aiding it to conserve the precious fuel on which its operation depends.

That is the special function of **"S-C" Regulation**—to Save Coal. It is doing so successfully on over 4,000 boilers today—to the tune of around **one million dollars' worth a year.**

By automatically feeding water in proportion to the boiler load, by keeping the water on an even and steady level when the load is even and by building up a high level when demand is low—storing heat, and allowing a lower level on peak loads—releasing heat, the waste of coal is prevented in the boiler room.

Steaming capacity of boilers is increased. The demands of peak loads are easily met. The life of boilers is lengthened and the labor of firemen lessened.

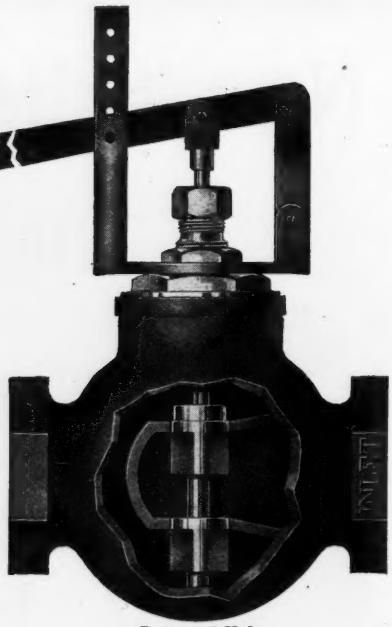
And Coal is Saved—Remember that important fact.

It's a good time to look into "S-C" Regulation. Don't you think so? Bulletin 50 tells all about it. Write for your copy.

The "S-C" Regulator Mfg. Co.

Feed Water Regulation Engineers **Fostoria, Ohio, U. S. A.**

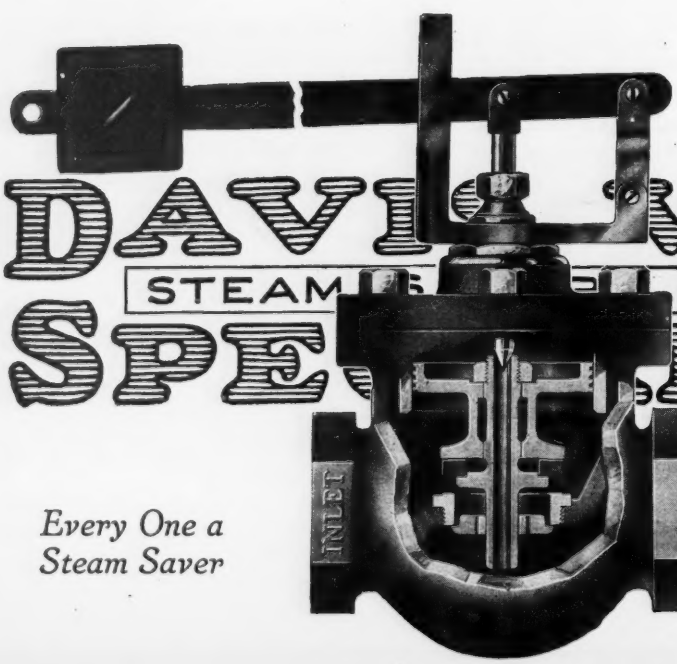
DAVIS WATER CONTROL AND BALANCED VALVES



Balanced Valve

Davis Water Control and Balanced Valves are designed for use on feed water heaters, condensation tanks, hot wells and for similar purposes. The Water Control Valve is quick opening and tight closing. It should be used where an absolutely tight valve is needed and is particularly well suited for use as a float operated inlet valve on feed water heaters. The Balanced Valve should be used for all purposes requiring a valve, the operation of which cannot be affected by the internal pressure.

These valves are the result of nearly a half century of valve building experience. Made of only the best materials, with the highest grade workmanship, they stand up under the most severe service. Both are made in a wide range of styles and sizes. For complete catalog showing these and other Davis Valve Specialties, just address the G. M. Davis Regulator Co., 429 Milwaukee Ave., Chicago. Branches in principal cities.



Water Control Valve

DAVIS VALVE SPECIALTIES

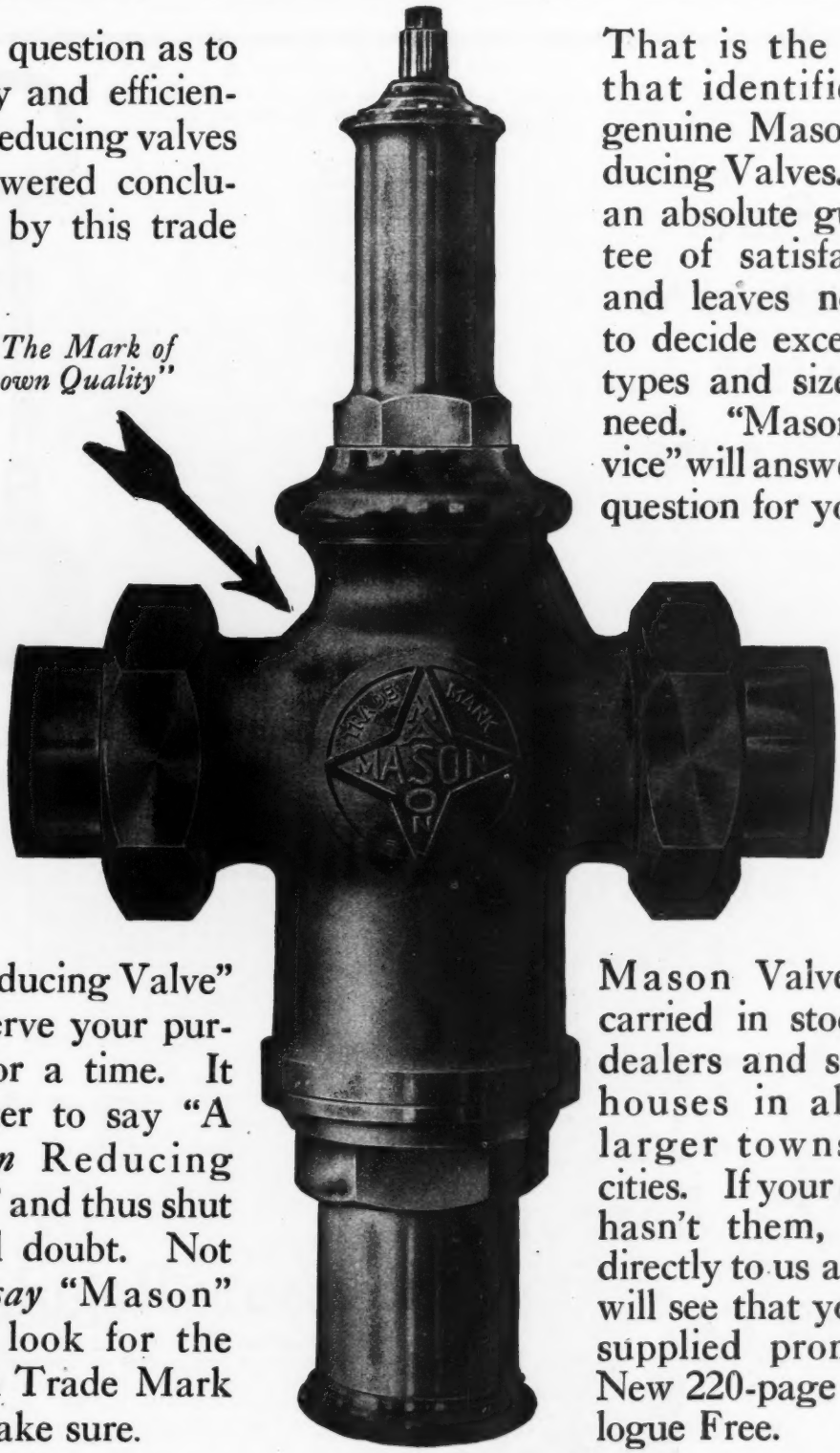
STEAM SINCE 1875

Every One a Steam Saver

Other Davis Valve Specialties are the Pressure Regulators (made in five styles), Float Valves, Back Pressure Valves, Exhaust Relief Valves, Water Relief Valves, Non-Return Valves, Stop and Check Valves, Steam Traps, Pump Governors, Flow Regulators and a number of other Steam Savers for every power plant.

Every question as to quality and efficiency in reducing valves is answered conclusively by this trade mark.

—"*The Mark of Known Quality*"



That is the mark that identifies the genuine Mason Reducing Valves. It is an absolute guarantee of satisfaction, and leaves nothing to decide except the types and sizes you need. "Mason Service" will answer *that* question for you.

"A Reducing Valve" *may* serve your purpose for a time. It is better to say "A *Mason* Reducing Valve" and thus shut out all doubt. Not only *say* "Mason"—but look for the Mason Trade Mark and make sure.

Mason Valves are carried in stock by dealers and supply houses in all the larger towns and cities. If your dealer hasn't them, write directly to us and we will see that you are supplied promptly. New 220-page Catalogue Free.

MASON REGULATOR CO.

DORCHESTER CENTER, BOSTON, MASS.

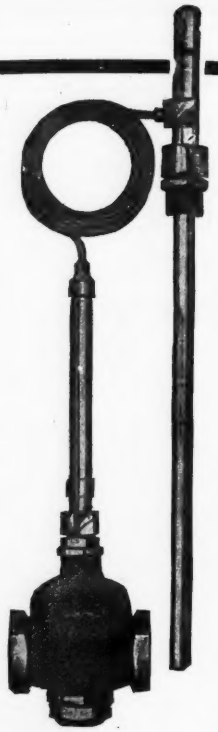
It won't cost you a cent to see for yourself how much more dependable service you can get out of a Sarco Temperature Control than you can get out of the Usual Temperature control.

Try a Sarco Temperature Control at Our Expense

Sarco is entirely self-contained and self-operated. Requires no electricity, compressed air or other outside agencies. Has no complicated connections or attachments. Is operated by the expansion and contraction of a sensitive but dependable oil that controls the valve.

Costs less than others to start with. Costs less to install. Costs nothing for upkeep. Has no rubber or leather diaphragms or other perishable parts.

The action of the Sarco is so positive and dependable that it gives entire satisfaction when used for the most delicate manufacturing processes as well as for room temperature control. Suitable for operating steam, water or gas valves.



You can lose nothing by trying out this compact, efficient temperature control **free of charge.**

Write us today for Booklet B-51 and full particulars of regulators for either tanks of room temperature.

SARCO CO., INC.
230 BROADWAY, NEW YORK

Ellicott Square, Buffalo
Monadnock Block, Chicago
Majestic Bldg., Detroit
Drexel Bldg., Philadelphia
Williamson Bldg., Cleveland
Peacock Bros., Montreal

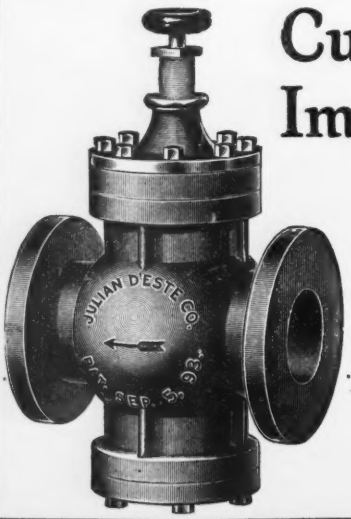
Keep Steam at the One Best Pressure

Economical operation and minimum maintenance as well as quality and quantity of production require the "one best pressure" wherever steam is used in heating or in manufacturing processes.

CURTIS ENGINEERING SPECIALTIES

Curtis Specialties have set the standard of service for over forty years.

Consult our engineering department.



Curtis Improved Steam Pressure Regulator

is both simple and sensitive, and delivers accurately and uniformly any lower pressure required from one to within a few pounds of the initial pressure. Made entirely of metal and occupies the space of a globe valve.

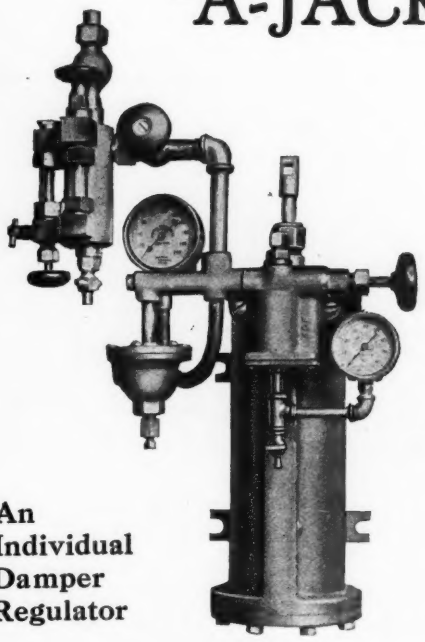
Without levers, weights or projections, glands or packing. All that passes in passes through without waste or loss. Can be used in connection with exhaust steam.

Used in steam heating, pulp and paper mills, dye-houses, rubber works, etc.

For full description of this and other Curtis Steam Specialties see our 1919 catalog, which will be sent upon request.

JULIAN D'ESTE COMPANY 174 N. Market St., Chicago
26 Canal Street, Boston, Mass. 83 Barclay St., New York

"A-JACKS" Damper Regulators



An Individual Damper Regulator

have demonstrated to many power plant operators that graduated control of draft is absolutely essential to secure the greatest economy in coal and to get the highest efficiency from the boilers.

Air supplied to the boiler in just the right amount and governed according to the steam pressure is given by them, assuring the most perfect combustion under varying conditions.

The "A-Jacks" is in a class by itself, unlike other types of regulators, because it dispenses with the auxiliary water supply line and operates solely on direct steam pressure. The clogging and deterioration of water valves is eliminated.

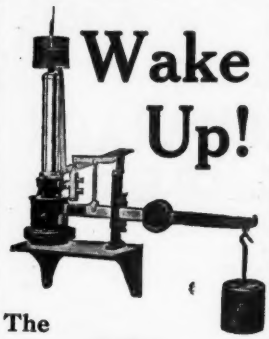
The control of damper, stoker, engine valve or rheostat are all regulated with equal perfection by the "A-Jacks."

No complicated parts. The installation is simple and inexpensive.

Let the A-Jacks benefit your plant as it has many others. We will be glad to show you how if you will write us for particulars.

National Regulator Company 208-212 S. Jefferson St. Chicago, Illinois

Wake Up!



"Is there an automatic damper regulator in working order.

That's the question the fuel administration was asking power plants last year.

How about YOUR plant?

You see now it's fully as important today as it was a year ago that damper adjustments be made promptly and properly to maintain economy in the use of coal.

Why not get the damper regulator that has been recognized for years as giving most perfect coal-saving action and the most continuous, trouble-free service?

That's the "R-K."

Why not let us send you the facts—at once?

The Trade R-K Mark

Reg. U. S. Patent Office.

Automatic Damper Regulator

Made by

RUGGLES-KLINGEMANN MFG. CO.

Formerly Walter G. Ruggles Co.

Manufacturers Complete Line of Regulating Valves

Send to

Good Agents Wanted Everywhere.

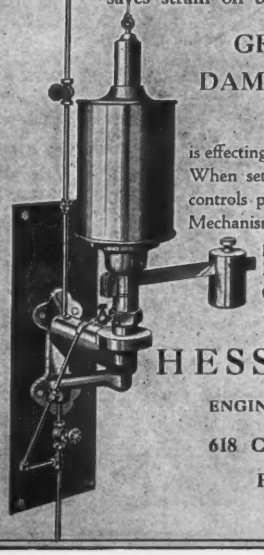
Franklin Williams, Inc., 39 Cortlandt St., New York. Trilley Sales Co., 417 S. Dearborn St., Chicago, Ill. Brogan & Co., 810 Race St., Philadelphia, Pa. R. E. Bronson Co., Century Bldg., Cleveland, O. L. E. Pollard Co., Met. Bank Bldg., Minneapolis, Minn. L. E. Pollard Co., First Nat. Bank Bldg., Omaha, Neb. Rochester Vac. Valve Co., Cox Bldg., Rochester, N. Y. E. J. MacMillan, 1005 Bates St., Grand Rapids, Mich. Kansas City Eng. Co., Scarritt Bldg., Kansas City, Mo.

Save the Coal and Give Ease to the Boiler

REGULATE draft according to the steam pressure—dampers open when pressure is low; closed when pressure rises. That kind of regulation saves *10 to 25 per cent.* in coal—saves strain on boilers—assures safety. The

GRAVITY STEAM DAMPER REGULATOR (AUTOMATIC)

is effecting these savings in over 5000 plants. When set at the desired pressure point it controls pressure within one or two pounds. Mechanism is simple. No diaphragms or packing. Requires no attention. Durable. Dependable. Our literature explains it fully. *Write for it*



HESS & BARKER

ENGINEERING MACHINISTS

618 CHESTNUT STREET

PHILADELPHIA, PA.

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TEMPERATURE INSTRUMENTS

Indicating Recording Controlling

When you specify *Tycos* you get dependable, durable instruments which meet exactly the particular needs for which they are designed: instruments that have behind them years of study and analysis of industrial temperature and pressure problems of every description.

Abroad and at home, in practically every line of industry where increased production at minimum cost is demanded, *Tycos* Indicating, Recording and Controlling Temperature Instruments are relied upon implicitly. They are their own best advertisements.

Complete information on any instrument or type of instruments on request.

Taylor Instrument Companies

ROCHESTER, N. Y. (XX)

A few of the many different kinds of instruments we make:

Industrial Thermometers (angle and straight stem)
Straight and Angle Stem Thermometers
Capillary Recording Thermometers
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Capillary Index (for dial) Thermometers
Thermoelectric Pyrometers
Recording Thermoelectric Pyrometers
Fery Radiation Pyrometers
Temperature Controlling Devices
Time Controls
Capillary Electric Contact Temperature Controls
Laboratory Engraved Stem Thermometers
Hygrometers (wet and dry bulb)
Indicating and Recording Thermographs
Coal Oil Testing Instruments
Hydrometers M. C.
Vacuum Gauges
Aneroid Barometers

There's a *Tycos* or *Taylor* Temperature Instrument for Every Purpose

"COLUMBIA" RECORDING GAUGES

This, gentlemen, is the "Columbia" chart. We make it as distinctive in appearance as possible because it is your guarantee for absolutely accurate records of Pressure, Vacuum and Draft. That's why we designed the original "day and night" border.

Our line of "Columbia" Recording Gauges covers every modern industrial requirement from the measurement of very low draft to the measurement of the highest hydraulic pressures.

And our "Columbia" Recorder is designed and built with a thorough understanding of industrial requirements. Accurate always, sensitive, sturdy and equipped with innumerable features that are positively exclusive.

Get our Catalog Section B100.

Schaeffer & Budenberg Manufacturing Co.

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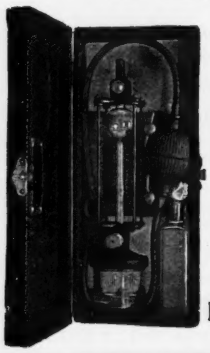
ALSO—Gauges for all Pressures, Vacuum and Draft. Thermometers, Tachometers, Counters, Calorimeters, Etc.

NO EXCUSE FOR WASTE



of fuel in firing when any engineer in any plant can get this

BACHARACH
Pocket CO_2 Indicator

for only a few dollars, which makes accurate CO_2 analyses at the rate of 17 to 20 per hour. Write for circular and what the U. S. Bureau of Mines says about this instrument.

Bacharach Industrial Instrument Co.
Commercial Bldg. Pittsburgh, Pa.

To EARN More—LEARN More

That's a truthful correspondence school slogan—but, Mr. Engineer, do you know that by using a Trill Indicator you will learn more of the principles of engines, pumps and compressors, especially the characteristics of your own machines, in a shorter time than by many hours of hard study? In fact, the discussion on engines in any text book refers directly to the indicator. Indicating is not only interesting and instructive but results in increased efficiencies, which is the point that attracts the attention of the boss.

In exchange for an indicator we allow $105 for $100 LIBERTY BONDS

Our easy payment plan for engineers is mighty interesting. You need an indicator—why not write today for our easy payment plan?

TRILL INDICATOR CO. Pine Street, Corry, Pa.

Why Use a Step-Ladder?

FOXBORO
TRADE MARK

DIAL TYPE THERMOMETERS

CAN BE READ EASILY FIFTEEN FEET AWAY

They have a long open scale, distinct indicator and white figures on a dull black ground.

They have no fragile glass parts to break, as the bulb and all connecting parts are made of metal.

They are made in both the long-distance and stem types, for ranges from—25 to +1000 Fahr.

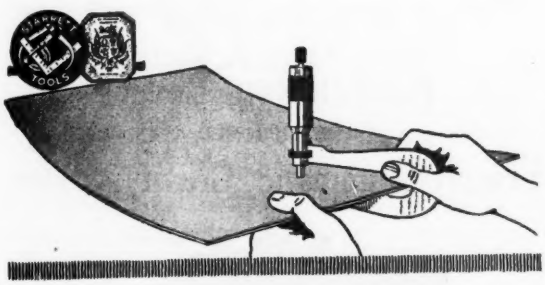
They are permanent in calibration and are guaranteed to withstand the hardest service. There is no mercury to separate.

In our new Power Plant Bulletin, D 115, you will find this instrument and others described. Send for it.

THE FOXBORO CO., Inc.

FOXBORO, MASS., U. S. A.

New York Chicago Pittsburgh San Francisco Birmingham Philadelphia Cleveland Tulsa St. Louis Peacock Bros., Montreal



A half turn on the lock nut makes a solid gage out of this Sheet Metal Micrometer. The ratchet friction feed insures uniform pressure against the work without danger of springing the frame. Like all Starrett Tools, it carries an absolute guarantee of accuracy and quality.

Write for catalog No. 21 "N."

The L. S. Starrett Co.

The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled

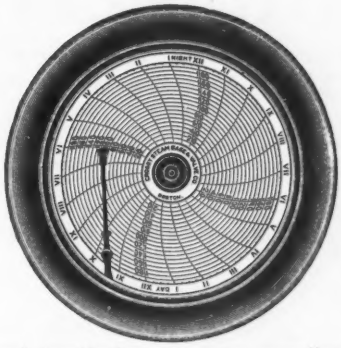
Athol, Mass.

42-999

Starrett Tools

CROSBY

The Pressure Recorder with Jeweled Clock Movement



A very sensitive and durable instrument for recording variations of pressure in a steam boiler.

The movement is enclosed in dust-proof case, pressure tube, has solderless joints, linkage for easy adjustment, and pen and pen table work in conjunction—all independent of the case—mounted on a socket extending to the boiler.

Chart rotates once in 24 hours. Practically no limit to range of pressure to be recorded.

Address our nearest store. It is located for your convenience.

TRADE MARK CROSBY

Works at Boston, Mass.

Crosby Steam Gage & Valve Company

New York Chicago London

60 Days' Free Trial

Checks Efficiency of Boiler Room

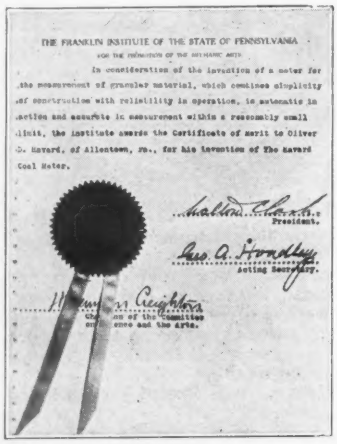
It isn't necessary for you to be on the job every minute in order to keep tab on the coal pile. A Havard will keep accurate record of fuel used when you are elsewhere, on a business trip or using your time to a better advantage. It even works while you sleep.

Any office boy is able to read the meter and make exact reports on where your coal is going, and how efficiently it is being burned under each boiler.

The Havard Coal Meter gives precisely as accurate a record as gas, electric or water meters. Power plants which have given them a thorough test pronounce them accurate.

Havard Coal Meters

measure coal instead of weighing it. Any possible chance of human errors is eliminated. The operation is scientifically and automatically performed.


THE FRANKLIN INSTITUTE OF THE STATE OF PENNSYLVANIA

In consideration of the invention of a meter for the measurement of granular material, which combines simplicity of construction with reliability in operation, is automatic in action and accurate in measurement within a reasonably small limit, the Institute awards the Certificate of Merit to Oliver D. Havard, of Allentown, Pa., for his invention of the Havard Coal Meter.

President.

Acting Secretary.

Franklin Institute Award.

It is simple and inexpensive, easy to install, making heavy, expensive equipment unnecessary.

Requires little or no repairs. Soft or hard coal is burned most economically whenever they are used. The Franklin Institute, at Philadelphia, without solicitation, gave it the highest award.

Try it for 60 days free.

Write for further details.

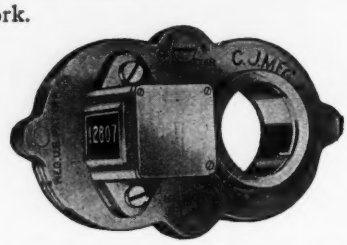
O. D. HAVARD CO., ALLENTOWN' PENNA.

Never Guess About Coal

Know **exactly** how much is burned under each boiler and what is **accomplished.**

C. J. Coal Meters

gives the absolute **facts** about your coal and an **indisputable record** of boiler performance. They spur firement to better and more **economical** work.



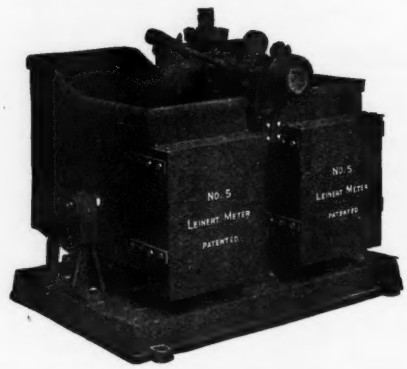
Our circular tells the story. Write for copy.

C. J. Manufacturing Co.
3427 North 5th Street **Philadelphia, Pa.**

"More Than A Meter" For WEIGHING Liquids

THE IMPROVED

Leinert Automatic Gravity Scales

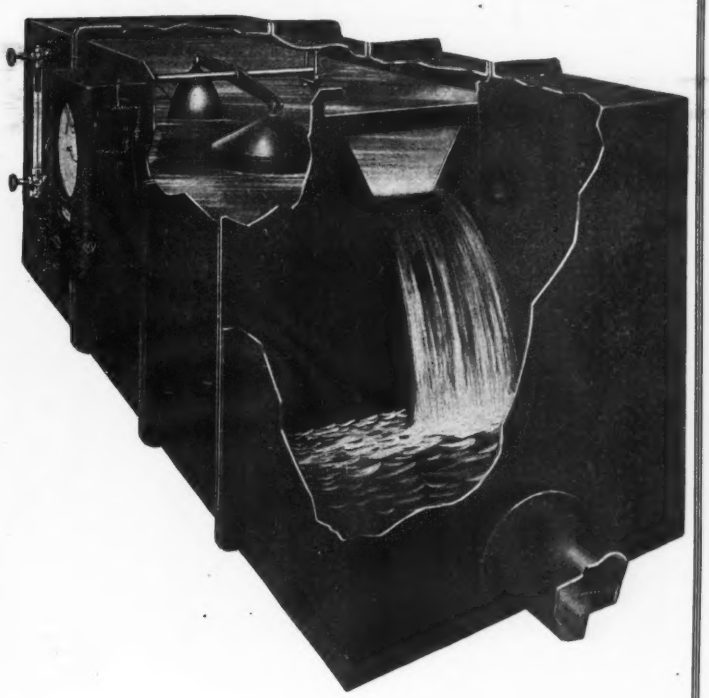


For Boiler Feed — Condensation Blow-Off

You Write Us for Book "A"

John Simmons Company
Valve-Piping & Steam Specialists
106 Center Street **NEW YORK**

More Dependably Accurate



You know the difference between occasional and dependable accuracy in a watch or a compass for instance. Then you can readily understand that we have built into every Bailey Meter of every type—**dependable** accuracy. For example,

BAILEY WEIR METERS

have all the accuracy of the V-notch or rectangular weir but with design so simplified and workmanship so perfected that accuracy of indication and record is dependably maintained.

Bailey Displacing Members are so designed and constructed that no changes can alter their motion from the exact proportion to rate of flow.

This motion is transmitted to the recording pen attached directly to the main shaft carrying the displacing members which shaft passes through a patent pressure-tight bearing in the side of the meter-tank. Cams, springs, flexible connectors, racks, gears, roller guides or other complications that cause inaccuracies and give rise to need of adjustments are entirely done away with in the Bailey Meter.

Even flooding of the tank cannot damage or impair the permanent accuracy of this meter while actual use in many plants show their continuous accuracy at all rates of flow.

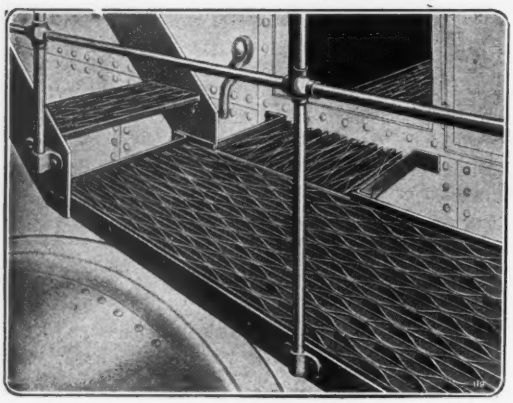
Write for bulletins and freely consult our engineering staff on all special metering problems.

BAILEY METER COMPANY

2013 E. 46th Street, Cleveland, Ohio Oliver Building, Boston, Mass.

IRVING SUBWAY TRADE MARK (PATENTED) REG. U.S. PAT. OFF. THE FIREPROOF VENTILATING FLOORING

IRVING SAFSTEP TRADE MARK (PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS



Safety and Comfort Combined

You can hurry all you wish, on a stair or ladder with **Irving Safsteps.** Your foot won't slip. No matter what kind of shoes you're wearing, the thin bars of the **Safstep** will grip them. No matter how greasy or oily or soapy the **Safstep** may be, your weight will force non-slipping contact with the edges of the bars. Even ice or snow cannot destroy this remarkable foot-gripping quality of the **Safstep.** And—besides—it is positively non-slipping throughout the life of the step. Let us send you Catalog 2A15.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Workers in Iron and Steel to Quality Standards and Manufacturers of

IRVING SUBWAY TRADE MARK (PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

A Costly Steam Pump or This Little Inexpensive

U. S. Automatic Injector—

WHICH SHALL IT BE?

Will you use two pumps or one pump and an injector? There's a mighty big difference between the cost of a pump and the cost of an injector. Think of the saving in eliminating just one pump. Of course, the injector you use will be the U. S. Injector. That's the standard injector throughout the country. Over 400,000 in use.

View herewith shows the simplicity of internal construction. Working parts are renewable in a jiffy. It is guaranteed to be the best injector on the market. If you do not find it so, send it back and we'll return your money.

American Injector Co.,
H 180 14th St., Detroit, Mich.

TRADE PENBERTHY MARK

Automatic Injectors Receive Tests That Tell

VERY PENBERTHY Injector undergoes the following **tests that tell** — before going to you:
Start Low—20-22 lb. steam on 3 ft. lift.
Work High — 165-170 lb. steam on 3 ft. lift.
Lift Water—20-24 ft. on 60-80 lb. steam.
Handle Hot Supply Water 120-130 deg. at 60-80 lb. steam.
115-120 deg. at 100 lb. steam.
95-104 deg. at 125 lb. steam and to do this automatically.

Write for the Catalog describing Ejectors — Automatic Water Gage—Automatic Cellar Drainer — Regrinding Valve, etc.

Penberthy Injector Company

(Established 1886)
DETROIT, MICH.
Canadian Plant: Windsor, Ont.
New York Depot: 71 Beekman St.

"MONCRIEFF"

The Only Genuine Scotch Gauge Glass

Every engineer who has used Moncrieff Gauge Glasses well understands why we want to call your attention to the fact that "Moncrieff" is a Scotch Glass, and the **only Genuine** Scotch Glass in the world.

Because the sands of Scotland have for centuries been known the world over as the best for making strong, tough glass. That's why "Moncrieff" Gauge Glasses are stronger and tougher than others. This you will realize just as soon as you once try "Moncrieff."

Made in 2 brands—"Perth" Brand for pressure up to 200 lbs.—"Unific" Brand for pressures up to 400 lbs.

May we send you the booklet? Write.

H. A. Rogers Company, 87 Walker Street, New York

Sole Agents for the United States

Don't Let Coal Stop You—Burn Oil

A **better, cleaner, cheaper** and more **efficient** fuel than mines produce. Thousands of users say it is. **They should know.**

HAMMEL Oil Burners

enable them to burn hydrocarbons of any gravity under boilers. Give an intense flame—a quick steam producer.

Flame is fan-shaped and reaches clear across firebox. Oil is atomized by steam jets and brought into intimate contact with air.

Perfect combustion, of course. Intensity of flame easily controlled to meet load conditions. No carbonizing.

Fuller details and partial list of satisfied users on request.

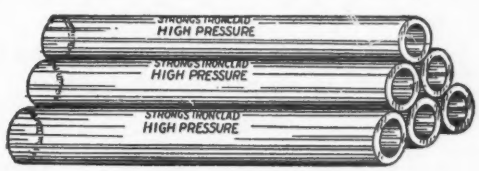
Hammel Oil Burning Equipment Co.

185 Devonshire St., Boston, Mass.

New York, N. Y. Providence, R. I. Portland, Me.

Gauge Glasses to be Trusted

They won't explode and put workmen in the hospital. They **will** protect boilers.



Strong's Ironclad High Pressure Gauge Glasses

are made of the **toughest** and most **durable** glass manufactured. They resist high pressure steam. The greatest industrial plants of the nation rely on them for safety.

The Strong Machinery & Supply Co.

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The best buy of the year

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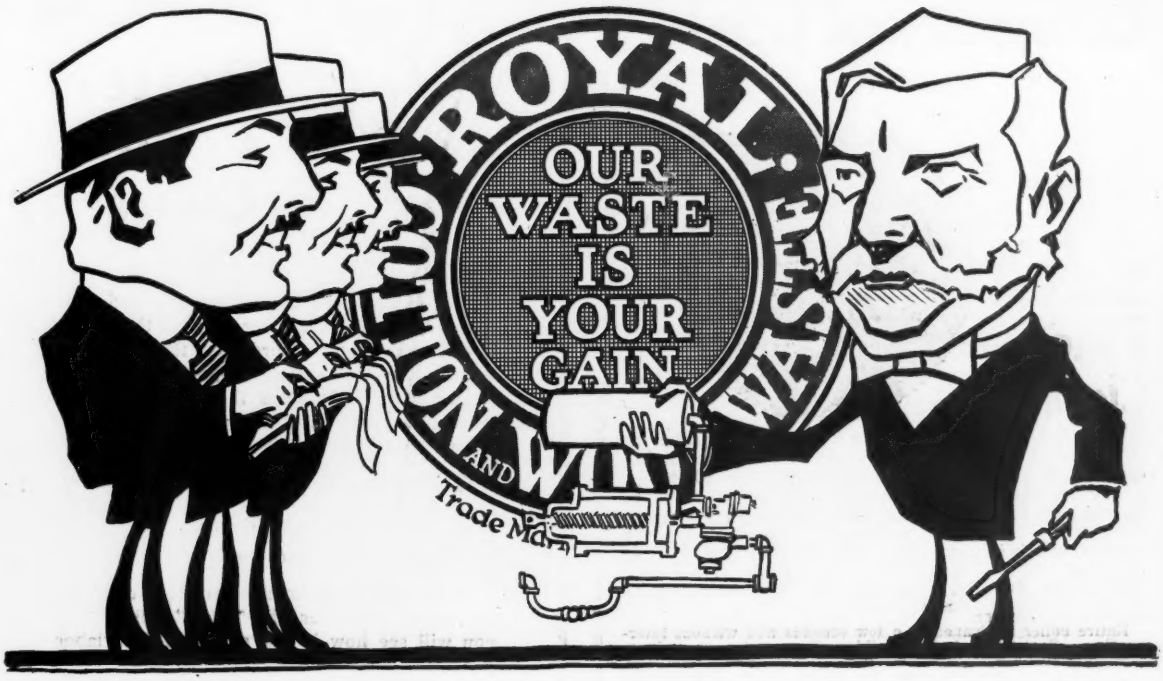

When Air Said 'Halt'

GEORGE WESTINGHOUSE

Inventor of the Air Brake, etc.

Born 1846 - Died 1914

In those days they had to start braking by hand when the train was a half-mile away from the stopping point. Accidents were frequent. By means of compressed air, Westinghouse achieved the "impossibility" of stopping the train in a moment.

EXPERIENCE with extraordinary happenings has taught us to use the word "impossible" with greater caution than formerly. In the days of Westinghouse buyers and users of Wiping Waste shrugged their shoulders at variations of quality, of weight, of "tare" (wrappings). "You can't get it *always* the same," they said.

But now you can. For **Royal Cotton Waste** is Standardized, Guaranteed for uniform quality, even weight and a 6% limit of "tare".

It is no longer an elaborate task to order and check your Waste. For Royal is ordered in a moment from sample and surely received as ordered. Certainty—Proficiency—Substantial Economy.

Ask your jobber or us for the Royal Sampling Catalogue, and for the booklet "Clean Clean Thru."

ROYAL COTTON AND WOOL WASTE — OUR WASTE IS YOUR GAIN — Trade Mark Reg. U.S. Pat. Off.

ROYAL MANUFACTURING Co.

General Sales Offices and Plant, RAHWAY, N. J.

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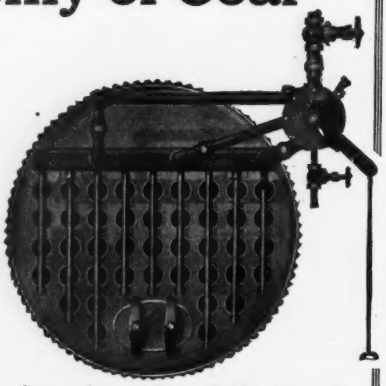
ROYAL COTTON AND WOOL WASTE — OUR WASTE IS YOUR GAIN — Trade Mark Reg. U.S. Pat. Off.

Economy of Coal

is impossible when boiler flues are soot lined. Heat cannot penetrate soot, and coal burned is largely wasted. The



National Flue Cleaner

enables firemen to have clean tubes all the time, to effect great savings in fuel and get full steaming capacity from boilers, without disagreeable labor.

The **National** system consists of a series of pipes clamped on the boiler front with a patented jet before each tube. The piping is divided into sections, into each of which in turn dry steam is admitted at will of operator.

when steam enters a section it is expelled forcibly from all the jets of the section, driving soot and ash to rear of the combustion chamber.

Entire boiler is cleaned in a few seconds and without interruption. System is indestructible. No repairs or upkeep. **Results guaranteed.**

In order that we can name you price, please state number of tubes in each of your return tubular boilers, also state whether uptake is front or rear.

Write for particulars and testimonials.

National Flue Cleaner Company, Inc.
Groveville, N. J.

CONTINUOUS FEED STETS CONTROL

Perfect Boiler Feed Control

is a vital necessity to any power plant.

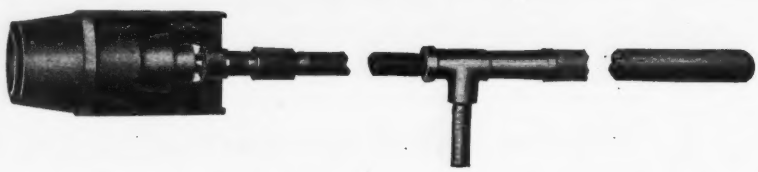
Stets Boiler Feed Control steadily and continuously supplies the water needs of the boiler. It **varies** the supply according to the need, thus making the boiler feed proportional to the steaming rate. It helps the boiler to carry extra demands, makes firing easier and coal consumption less.

No complicated parts to get out of order. A compensating pressure float—no stuffing boxes. Perfectly balanced. It increases power and assures steady plant operation.

If you will write immediately for our booklet, which describes the "Stets" completely, you will see how it will save you both labor and money. It's free.

The Williams Gauge Company
643-5-7 Fourth Ave., Pittsburgh, Pa.

A Real Fuel Saver



Sent on Trial

The Tornado Boiler Tube Cleaner Does the Work with Dry Air

by just using enough steam through ½-inch hose to secure a strong, continuous blast. More efficient and economical than scraper or brush.

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Standard in the World's Largest Power Plants

Every boiler needs a mechanical soot blower. Leaders of world industry, such as General Electric, Ford Motor, Du Pont Powder, Standard Oil, have found Diamond design and construction superior. If your boilers are not equipped, write for Bul etin 180.

DIAMOND POWER SPECIALTY COMPANY
Detroit, Michigan

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

SMOOTH-ON ELASTIC CEMENT No3

For Tight Joints

Screw thread joints made with SMOOTH-ON ELASTIC CEMENT No. 3 are surely made, not "may be" made. SMOOTH-ON expands as it sets—seals the tiny irregularities that ordinary jointing compounds never catch. Order a 5-lb. can today from your Supply House.

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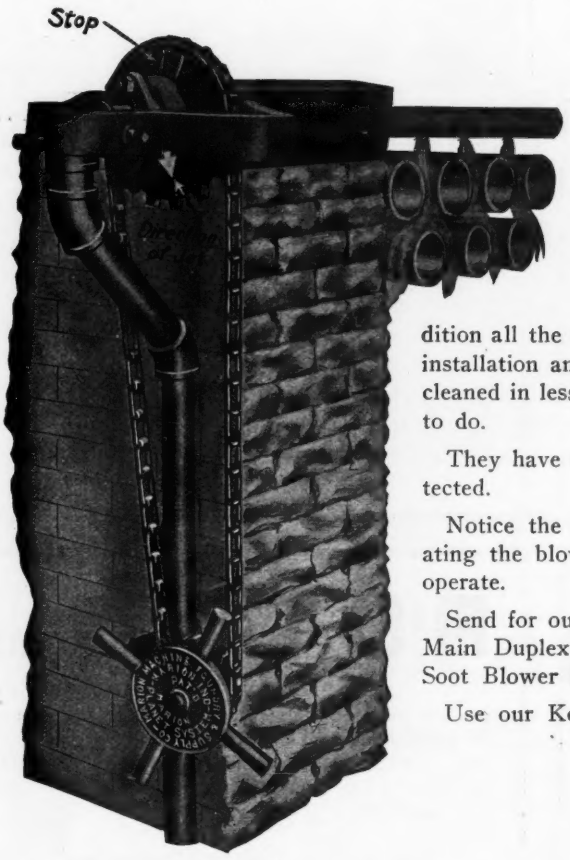


Marion Planet Soot Blowers

For all types of water tube boilers

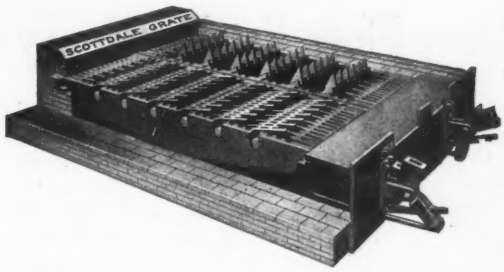
Blow the soot and ash from your boiler tubes with the Marion Planet Steam Soot Blower and have them in 100% working condition all the time. The Planet Soot Blower is a permanent installation and always ready to use. All the tubes can be cleaned in less than five minutes. The job is clean and easy to do.

They have the internal welded nozzle, which is fully protected.

Notice the hand wheel and chain arrangement for operating the blowers. This makes them positive and easy to operate.

Send for our catalog on soot blowers. We also make the Main Duplex Front End Blower and the Marion Rotary Soot Blower for return tubular boilers.

Use our Keystone Draft Blower for bad coal.



Marion Scottdale Grates

The Scottdale Grate is a rocking and dumping grate for bad clinkering coals. It has a rocking movement that sifts out the fine ash, and a full dumping movement that drops all clinkers into the ash pit.

Get our catalog on grates, which is a complete hand book on combustion. Free for the asking.

We also manufacture the Shear-Klean Grate, which will handle low grade coals without wasting the fuel.

Marion Hand Stokers will meet the smoke ordinance and save coal at the same time. Write for details.

Marion Machine, Foundry & Supply Company

Box 400, Marion, Indiana

8 Barrel Loads of Scale

This letter speaks for itself:

Berea, Ohio, April 15, 1919.

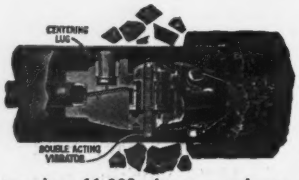
The General Specialty Co.,
Buffalo, N. Y.

Gentlemen:—We are very pleased to inform you that last Saturday we used the "Torpedo" and obtained 8 barrel loads of scale. We therefore feel that the remover has paid for itself in this one operation.

Yours very truly,
The Dunham Company.

We don't feel that we can say anything more forcible in favor of

The "Torpedo"



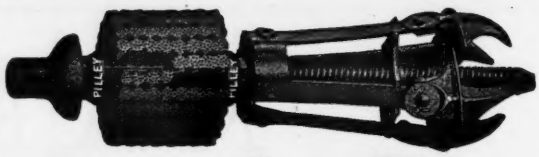
It does its work and does it well. Operated by air or steam, it goes into the tubes and shakes off scale—finds it where unsuspected.

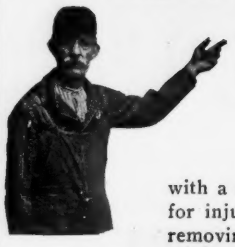
Cleans a boiler in 2 to 4 hours by lightly tapping 11,000 times a minute on the tubes. Sets up vibration. Brittle scale cracks and falls off. That's all.

We would like you to give the "Torpedo" a free trial on one boiler. We'll send it to you. Afterward, it's up to you.

The General Specialty Company

69 Carroll Street, Buffalo, N. Y.





Save Tubes by Cleaning Them

with a device which allows no chance for injury to them, at the same time removing every bit of soot.

PILLEY'S COMBINATION BRUSH AND SCRAPER

is a compact and simple device, perfectly fitted for this purpose.

The brushes are of highly tempered wire. The collapsible scraper ends allow easy insertion into the tube, and by reverse turn of the handle they are expanded to the tube's diameter.

Soot cannot cake or stick, for no steam is used.

Made in sizes for tubes 2 in. to 6 in.

A speedy and efficient worker which makes steaming capacity jump.

Write now for fuller details.

Pilley Packing and Flue Brush Mfg. Co.

611 S. Third Street, St. Louis, Mo.
Eastern Office: 71 Fulton St., New York
Price. $1.00 Per Diameter Inch.

Dirty Flues Eat Up Money Keep 'em Clean

Get the **Ruggles "Perfection"** and watch boiler capacity jump while coal bills drop.

The **best** flue cleaner made—bar none. Light and simple, but very strong. Efficient and **dependable.** Works like a plane with a tendency to get in deeper all the time.

Knives have a long, shearing cut against which incrustations of soot, ash and dirt are helpless. Have the flexibility that enables them to override flue imperfections, such as blisters or welds. Indispensable and easily operated. **Guaranteed** to do the work.

Order from your dealer or direct from

Ruggles & Ruggles

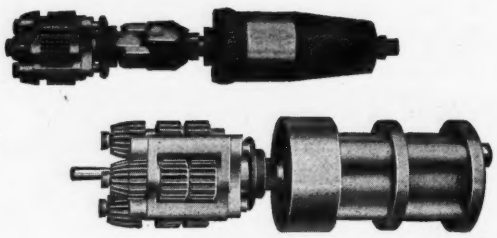
Batavia, Ill.

ROTO TUBE CLEANERS

are the efficient, simple and easily operated means of maintaining that cleanliness in all types of Boilers, Condensers, Economizers, Evaporators, etc., which is so supremely essential to safe and economical operation.

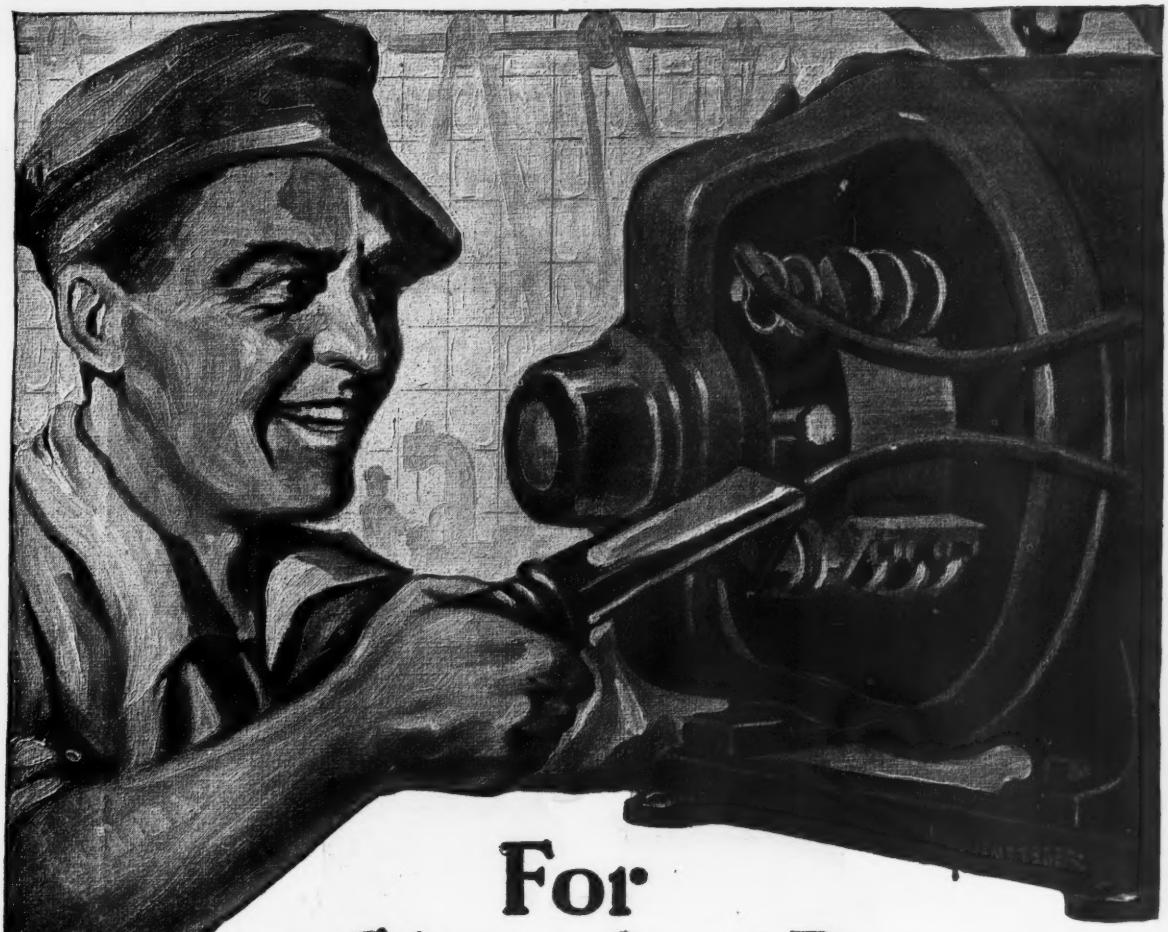
Write to Tube Cleaning Headquarters for consultation on your cleaning problems.

Type W. D.—Driven by Water Pressure
Type A. D.—Driven by Air or Steam



THE ROTO COMPANY

96 TEMPLE STREET **HARTFORD, CONN.**



For ery Cleaning Purpose

A TUEC Suction Plant is Most Efficient and Economical

A Few Uses for TUEC Suction Systems

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Printers—for Cleaning Flax from Paper
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and Scores of Others

THE intrinsic value of some kinds of industrial dust is so great that it can be salvaged at a very substantial profit—as cork dust, and chips, gold filings, saw-dust, cement from the fabric of empty sacks, sulphur from rubber tire fabric, etc. Other forms of dust are so highly destructive that they must be collected and imprisoned right where they are produced and not permitted to settle on delicate machinery—as coal dust, silk, wool and cotton lint, soot in steam boiler flues, etc., etc. While conservation and economy demand that floors, walls, ceilings and other surfaces be frequently cleaned of all deposits of *ordinary* dust.

Almost every week some new application of TUEC Dust-Removing SUCTION POWER is discovered by ourselves or some manufacturer. No matter how unique your problem may appear to you, it will pay you to get our advice and suggestions, without any obligations.

Our experience proves that only one factory in thirty can afford to cling to the inefficient broom and brush method of cleaning and removing dust.

Write for full information. Let us tell you what TUEC service is doing for others **in your line.**

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General Offices, Canton, Ohio, U. S. A.
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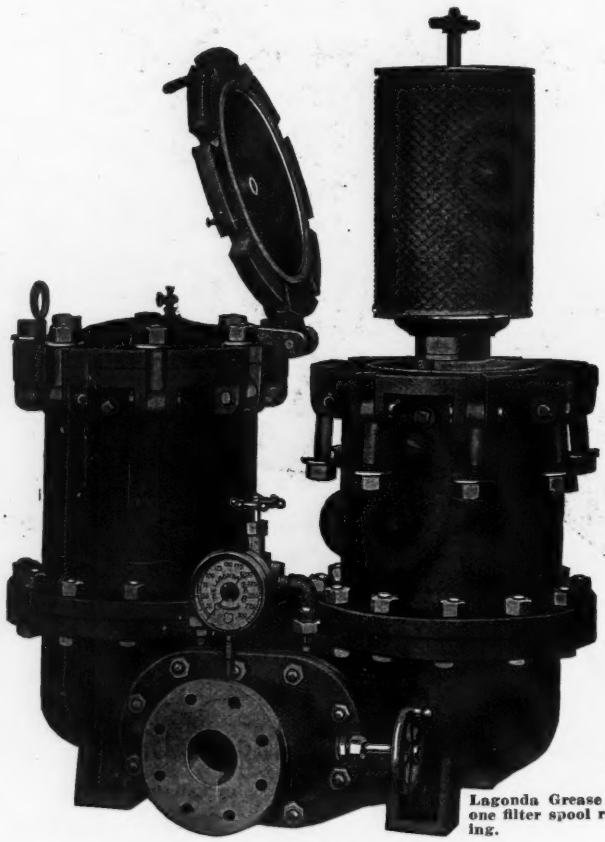
More TUEC Stationary Vacuum Cleaning Plants have been supplied to factories, mills, office buildings, hotels, schools, theatres, hospitals, public buildings, steamships, railroad depots, etc., than of any other make. We'll be glad to tell you why.

Multiple Filtration Double Capacity Easy to Clean



Lagonda Grease Extractor, showing one filter spool removed, as in cleaning.

Lagonda Grease Extractors

are correct. Judge for yourself.

Are they thorough? All water filtered through five layers of filter cloth; Multiple Filtration.

Is it necessary to cut them out for cleaning? No. They have two units; one is always in service while the other is out for cleaning. Using both chambers gives double capacity.

How about cleaning? Very easy and simple. See the illustration above. Lift out the filter spool, wind on a clean length of cloth, replace.

The outfit takes up small space. Materials and workmanship are strictly guaranteed. Let us give full information about this ideal power plant filter.

The Lagonda Mfg. Co.
SPRINGFIELD, OHIO.
FUEL SAVING SPECIALISTS

NEW YORK, BOSTON, PHILADELPHIA, ST LOUIS, CHICAGO, DETROIT, DALLAS, SAN FRANCISCO, ST. PAUL, MONTREAL, LONDON

Makers of Lagonda Boiler Tube and Condenser Tube Cleaners, Tube Cutters, Cap and Header Reseating Machines, Automatic Valves, etc.

The Power Plant Records and Analysis Number

Directly bearing on the questions most vital to this nation and to the existence of civilization itself; making clear the fundamental principles on which any real improvement must be based; presenting in a plain, concise way the most modern methods of increasing and maintaining efficiency, we firmly believe the forthcoming January 1st number of POWER PLANT ENGINEERING will be the most important and valuable publication that has ever appeared in the power plant engineering field.

A veritable exposition of the most reliable firms making the most modern equipment, its advertising as well as its editorial pages will be the almost daily reference guide of consulting engineers, operating engineers, purchasing agents and every man who has to deal with any phase of the present and future conditions under which power must be generated, distributed and utilized.

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Pratt & Cady Co. Inc., Hartford, Conn.
Hooven, Owens, Rentschler Co., Hamilton, Ohio.
CEMENT, ASBESTOS.
Johns-Manville Co., H. W., New York.
New York Belting & Packing Co., New York.
CEMENT, BELT.
Graton & Knight Mfg. Co., Worcester, Mass.
CEMENT, HIGH TEMPERATURE.
Jointless Fire Brick Co., Chicago.
Quigley Furnace Spec. Co., Inc., New York.
CEMENT, IRON.
Johns-Manville Co., H. W., New York.
Smooth-On Mfg. Co., Jersey City.
Lakeside Bridge & Steel Co., Milwaukee.
Portable Machinery Co., Inc., Passaic.
Shepard Elec. Crane & Hoist Co., Montour Falls, N. Y.
Link-Belt Company, Chicago.
Specialty Eng'r'g Co., Philadelphia, Pa.
CO_2 RECORDERS.
Foxboro Co., The, Foxboro, Mass.
COCKS, AIR & STEAM.
Dart Mfg. Co., E. M., Providence, R. I.
Kelly & Jones Co., Greensburg, Pa.
Lunkenheimer Co., Cincinnati.
Michigan Lubricator Co., Detroit, Mich.
Powell Co., The Wm., Cincinnati.
Pratt & Cady Co. Inc., Hartford, Conn.
Williams Valve Co., D. T., Cincinnati.
COCKS, BLOWOFF.
Powell Co., Wm., Cincinnati.
Pratt & Cady Co. Inc., Hartford, Conn.
Scully Steel & Iron Co., Chicago.
Williams Gauge Co., Pittsburgh.
COILS AND BENDS.
Badger & Sons Co., E. B., Boston, Mass.
COMBUSTION APPLIANCES.
Bailey Meter Co., Cleveland, O.
Uehling Inst. Co., New York.
COMBUSTION (Co_2) RECORDER.
Sarco Company, Inc., New York
Uehling Instrument Co., New York.
COMBUSTION ARCHES.
Betson Plastic Fire Brick Co., Rome, N. Y.
Jointless Fire Brick Co., Chicago.
McLeod & Henry Co., Troy, N. Y.
Quigley Furnace Specialties Co., New York.
COMMUTATOR DRESSER.
Ideal Commutator Dresser Co., Chicago, Ill.
COMPOUND, BOILER.
Dearborn Chemical Co., Chicago
Plant Eng'r'g & Equip. Co., New York.
COMPOUND PIPE JOINT.
Dixon Crucible Co., Jos., Jersey City.
Johns-Manville Co., H. W., New York.
Smooth-On Mfg. Co., Jersey City.
CONDENSERS.
American Steam Pump Co., Battle Creek, Mich.
Anderson Co., The V. D., Cleveland.
Cameron Steam Pump Works, A. S., New York.
Dean Bros., Steam Pump Works, Indianapolis.
Griscom-Russell Co., New York
Ingersoll-Rand Co., New York, N. Y.
Manistee Iron Works, Manistee, Mich.
Ross Heater & Mfg. Co., Buffalo.
Westinghouse Electric & Mfg. Co., Pittsburgh.
Wheeler Cond. & Eng'r'g Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Philadelphia.
Worthington Pump & Machinery Corp., New York.
CONDUIT, FLEXIBLE STEEL.
Westinghouse Machine Co., Pittsburgh, Pa.
CONDUIT FOR UNDERGROUND HEATING PIPES.
Ric-Wil Co., Cleveland, O.
CONNECTORS, SOLDERLESS.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
CONVEYORS.
Brady Fdry. Co., James A., Chicago.
Gifford-Wood Co., Hudson, N. Y.
Godfrey Conveyor Co., Elkhart, Ind.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Company, Chicago.
Portable Machinery Co., Inc., Passaic, N. J.
Specialty Eng'r'g Co., Philadelphia, Pa.
COOLING SYSTEMS.
Spray Eng'r'g Co., Boston.
Wheeler Cond. & Eng'r'g Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Philadelphia.
COOLING TOWERS.
Wheeler Cond. & Eng'r'g Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Philadelphia.
Worthington Pump & Machinery Corp., New York.
CORDAGE.
Waterbury Co., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn

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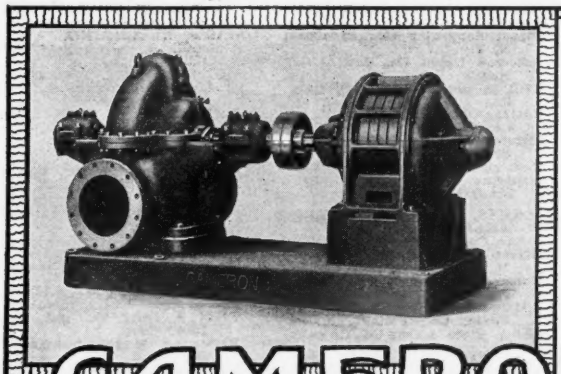
BOILER SETTINGS.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Budd Grate Co., Philadelphia.
Harbison Walker Ref. Co., Pittsburgh, Pa.
Johns-Manville Co., H. W., New York.
Jointless Fire Brick Co., Chicago.
McLeod & Henry Co., Troy, N. Y.
Quigley Furnace Specialties Co., New York.
BOILER TUBE CLEANERS.
Cleveland Flue Cleaner Mfg. Co., Cleveland.
General Specialty Co., Buffalo.
Huyette Co., The Paul B., Phila
Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg. Co., Pittsburgh.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis.
Roto Co., The, Hartford, Conn.
Ruggles & Ruggles Co., Batavia, Ill.
Scully Steel & Iron Co., Chicago.
Self-Cleaning Strainer Co., Chicago.
United Electric Co., Canton, O.
BOILER TUBE PROTECTORS.
Cruise & Co., Elizabeth, N. J.
BOILER TUBES.
Mark Mfg. Co., Evanston, Ill.
National Tube Co., Pittsburgh.
Scully Steel & Iron Co., Chicago.
BOILERS.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Ames Iron Wks., Oswego, N. Y.
Babcock & Wilcox Co., New York, N. Y.
Badenhausen Co., Philadelphia.
Bigelow Co., The, New Haven, Conn.
Chandler & Taylor Co., Indianapolis, Ind.
Connelly Boiler Co., The D., Cleveland, O.
Freeman Mfg. Co., Racine, Wis.
Edge Moor Boiler Co., Edge Moor, Del.
Erie City Iron Works, Erie, Pa.
Heine Safety Boiler Co., St. Louis.
Ladd Co., Geo. T., Pittsburgh.
Strong Machy. & Supply Co., New York.
CHAIN PIPE WRENCHES.
Williams & Co., J. H., Brooklyn.
CHAINS, DRIVE.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Company, Chicago.
Morse Chain Co., Ithaca, N. Y.
CHAINS, POWER TRANSMISSION.
Morse Chain Co., Ithaca, N. Y.
CHAIN WHEELS.
Babbitt Steam Spec. Co., New Bedford, Mass.
Crane Company, Chicago.
CHIMNEYS.
Heinicke, Inc., H. R., New York.
Bigelow Co., The, New Haven, Conn.
Springfield Boiler Co., Springfield, Ill.
CLOCKS.
Ashton Valve Co., Boston.
Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
COAL AND ASH HANDLING MACHINERY.
Brady Fdry. Co., James A., Chicago.
Gifford-Wood Co., Hudson, N. Y.
Godfrey Conveyor Co., Elkhart,
Green Engineering Co., East Chicago, Ind.
Jeffrey Mfg. Co., Columbus, O.
Lakeside Bridge & Steel Co., No. Milwaukee, Wis.
Link-Belt Company, Chicago.
Portable Machinery Co., Inc., Passaic, N. J.
Shepard Elec. Crane & Hoist Co., Montour Falls, N. Y.
Specialty Eng'r'g Co., Phila
COAL CRUSHERS.
Fuller-Lehigh Co., Fullerton, Pa.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Company, Chicago.
Specialty Eng'r'g Co., Phila
COAL PULVERIZING EQUIPMENT.
Fuller Lehigh Co., Fullerton, Pa.
COAL STORAGE EQUIPMENT.
Gifford-Wood Co., Hudson, N. Y.
Godfrey Conveyor Co., Elkhart,



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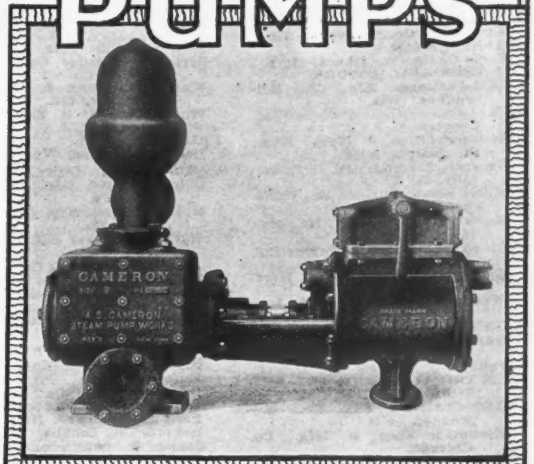

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Unitlex Coupling Co., Philadelphia, Pa.

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Jefferson Union Co., Lexington, Mass.
Mark Mfg. Co., Evanston, Ill.

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Link-Belt Company, Chicago.
Shepard Elec. Crane & Hoist Co., Montour Falls, N. Y.

DIE STOCKS.
Armstrong Mfg. Co., Bridgeport, Conn.
Crane Co., Chicago.
Curtis & Curtis Co., Bridgeport, Conn.

DRILLS, COMPRESSED AIR AND ELECTRIC.
Chicago Pneumatic Tool Co., Chicago.
Mark Mfg. Co., Evanston, Ill.

DRIVES, CHAIN.
Morse Chain Co., Ithaca, N. Y.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Engbergs Elec. & Mech. Wks., St. Joseph, Mich.
General Electric Co., Schenectady, N. Y.
Moore Steam Turbine Co., Wellsville, N. Y.
Manistee Iron Works, Manistee, Mich.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Electric & Mfg. Co., Pittsburgh.

EJECTORS.
Hayden & Derby Mfg. Co., New York.
Penberthy Injector Co., Detroit.

ELECTRICAL MACHINERY AND SUPPLIES.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Economy Fuse & Mfg. Co., Chicago.
General Electric Co., Schenectady, N. Y.
Ridgway Dynamo & Eng. Co., Ridgway, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh.

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Nicholson & Co., W. H., Wilkesbarre, Pa.
Robertson & Sons, Jas. L., New York.

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Coe Co., C. T., Newark, N. J.
Hess & Barker, Philadelphia, Pa.

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Erie City Iron Works, Erie, Pa.
Griscom-Russell Co., New York.
Hooven, Owens, Rentschler Co., Hamilton, Ohio.
Nordberg Mfg. Co., Milwaukee.
Ridgway Dynamo & Eng. Co., Ridgway, Pa.
Skinner Engine Co., Erie, Pa.
Troy Eng. & Mach. Co., Troy, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Westinghouse Machine Co., Pittsburgh.
Worthington Pump & Machinery Corp., New York.

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Hoppes Mfg. Co., Springfield, O.
Patterson-Kelley Co., The, New York.
Robertson & Sons, Jas. L., New York.
Sims Co., The, Erie, Pa.
Watson & McDaniel Co., Philadelphia.

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Griscom-Russell Co., New York.
Lagonda Mfg. Co., Springfield, O.
Sims Co., The, Erie, Pa.

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General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., Pittsburgh.
Wing Mfg. Co., L. J., New York.

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Power Turbo-Blower Co., New York.
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Sims Co., The, Erie, Pa.
Springfield Boiler Co., Springfield, Ill.
Wayne Oil Tank & Pump Co., Ft. Wayne, Ind.
Wheeler Cond. & Eng'r'g Co., Carteret, N. J.

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Bashlin Co., The, Warren, Pa.

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Griscom-Russell Co., New York.
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Refinite Co., Omaha, Neb.
Scaife & Sons Co., Wm. B., Pittsburgh.
Wheeler Mfg. Co., C. H., Philadelphia.

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Hoppes Mfg. Co., Springfield, O.
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Kieley & Mueller, Inc., New York.
Patterson-Kelley Co., The, New York.
Robertson & Sons, Jas. L., New York.
Ross Heater & Mfg. Co., Buffalo.
Sims Co., The, Erie, Pa.

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Refinite Co., Omaha, Neb.

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FILTERS, OIL.
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Farnsworth Co., Conshohocken.
General Electric Co., Schenectady, N. Y.
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Northern Equipment Co., Erie.
Mason Regulator Co., Boston.
S-C Regulator Co., Fostoria, O.
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Williams Gauge Co., Pittsburgh.

GRAPHITE.
Dixon Crucible Co., Jos., Jersey City.

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Dixon Crucible Co., Jos., Jersey City.

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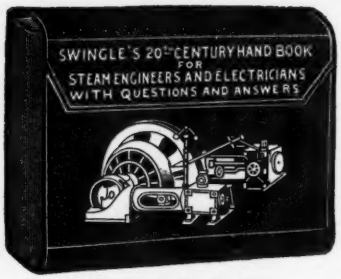
Coe Co., C. T., Newark, N. J.
Flynn & Emrich Co., Baltimore.
"Huber Hand Stoker."
Herrick, Geo. S., Syracuse, N. Y.

GRATES, CHAIN.
Armstrong Mfg. Co., Springfield, Ohio.
Brady Fdry. Co., Jas A., Chi-



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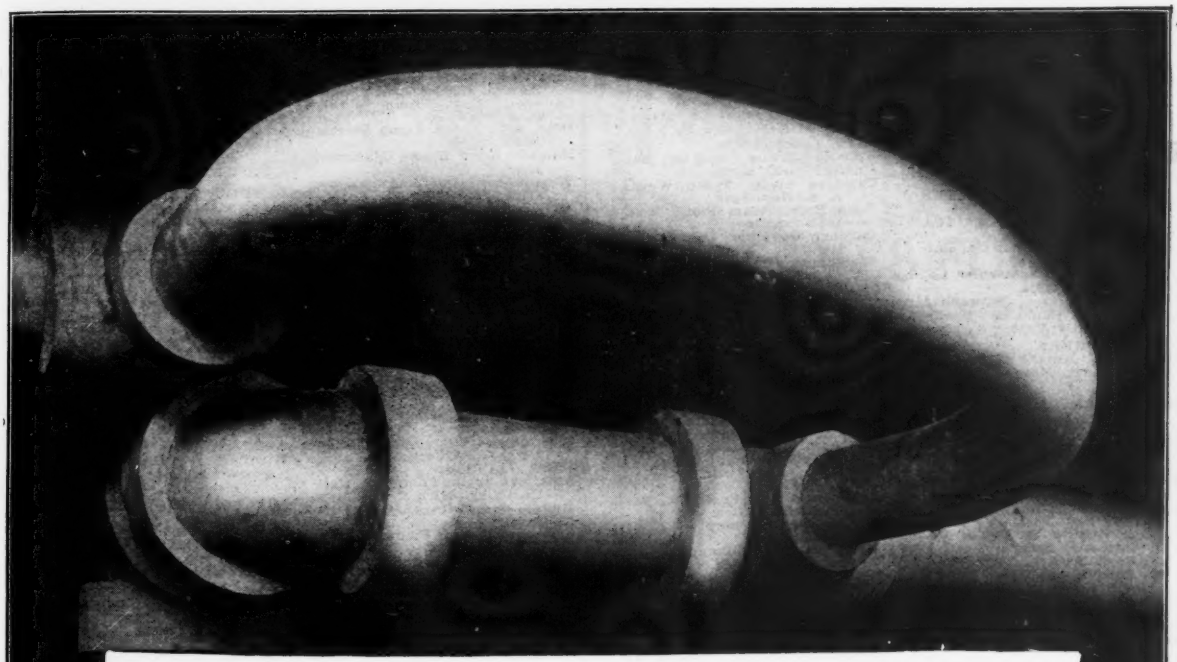

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Yarnall-Waring Co., Philadelphia.

PYROMETERS.
American Steam Gauge & Valve Mfg. Co., Boston.
Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Cos., Rochester, N. Y.
Uehling Instrument Co., New York, N. Y.

RECORDING INSTRUMENTS.
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Defender Auto. Regulator Co., St. Louis, Mo.
Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Cos., Rochester, N. Y.
Uehling Instrument Co., New York, N. Y.
Yarnall-Waring Co., Philadelphia.

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Robertson & Sons, Jas. L., New York, N. Y.

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d'Este Co., Julian, Boston.
Hess & Barker, Philadelphia.
Kieley & Mueller, Inc., New York.
Mason Regulator Co., Boston.
National Regulator Co., Chicago.
Power Turbo-Blower Co., New York.
Sarco Company, Inc., New York.
Wing Mfg Co., L. J., New York.

REGULATORS, FEED WATER.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Elliott Co., Pittsburgh, Pa.
Farnsworth Co., Conshohocken, Pa.
Foster Eng'r'g Co., Newark, N.J.
Lagonda Mfg. Co., Springfield, Ohio.
Northern Equipment Co., Erie, Pa.
S-C Regulator Co., Fostoria, O
Squires Co., The C. E., Cleveland.
Williams Gauge Co., Pittsburgh
Wing Mfg Co., L. J., New York

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National Regulator Co., Chicago.
Sarco Co., Inc., New York.
Taylor Instrument Cos., Rochester, N. Y.

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Leavitt Machine Co., Orange, Mass.
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Hoppes Mfg. Co., Springfield, Ohio.
Kieley & Mueller, Inc., New York.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
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Pittsburgh Valve, Foundry, & Const. Co., Pittsburgh, Pa.
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Springfield Boiler Co., Springfield, Ill.

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Diamond Power Specialty Co., Detroit, Mich.
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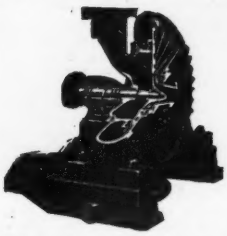

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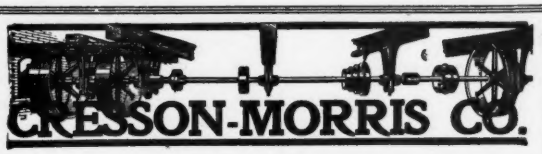

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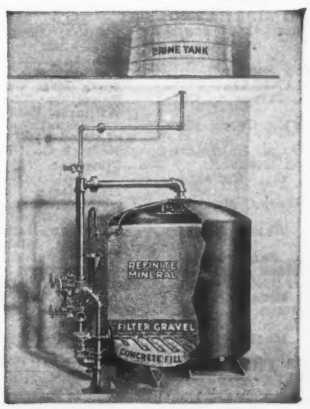

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Vasil Steam Systems Co., Washington, D. C.
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Combustion Eng'r'g Corp., New York.
Underfeed Stoker Co. of America, Detroit, Mich.
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Crane Co., Chicago.
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Springfield Boiler Co., Springfield, Ill.
Wayne Oil Tank & Pump Co., Ft. Wayne, Ind.

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Foxboro Co., The, Foxboro, Mass.
National Regulator Co., Chicago.
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Taylor Instrument Cos., Rochester, N. Y.

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Schaeffer & Budenberg Mfg. Co., Brooklyn.

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Powell Co., The Wm., Cincinnati.
Williams Valve Co., D. T., Cincinnati.

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Crane Co., Chicago.
Elliott Co., Pittsburgh.
Homestead Valve Mfg. Co., Homstead, Pa.

VALVES, BOILER.
Chapman Valve Mfg. Co., The, Indian Orchard, Mass.
Lunkenheimer Co., Cincinnati.
Powell Co., Wm., Cincinnati.
Scott Valve Mfg. Co., Detroit.

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Nelson Valve Co., Philadelphia.
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Powell Co., Wm., Cincinnati.
Pratt & Cady Co. Inc., Hartford, Conn.
Schiller, Jos. F., Philadelphia.
Scully Steel & Iron Co., Chicago.
Williams Valve Co., D. T., Cincinnati.
Yarnall-Waring Co., Phila.
Chapman Valve Mfg. Co., The, Indian Orchard, Mass.
Crane Co., Chicago.
Lunkenheimer Co., The, Cincinnati.
Mason Regulator Co., Boston.
Nelson Valve Co., Philadelphia.
Scott Valve Mfg. Co., Detroit.

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Nelson Valve Co., Philadelphia.
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Williams Valve Co., D. T., Cincinnati.

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Lunkenheimer Co., The, Cincinnati.
Nelson Valve Co., Philadelphia.
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Pittsburgh Valve, Foundry. & Const. Co., Pittsburgh, Pa.
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Kieley & Mueller, Inc., New York.
Mason Regulator Co., Boston.
National Regulator Co., Chicago.
Nelson Valve Co., Philadelphia.
Ohio Brass Co., The, Mansfield, Ohio.
Ruggles-Klingemann Mfg. Co., Boston.
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Quick Action Opportunities

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Advertisements in the Signboard Section which come under the classifications "Position Wanted," "Help Wanted," "Salesmen and Agencies," "Business Opportunities," "Patent and Patent Attorneys" and "Technical Books" will be set in type as shown below and published at the rate of

30 cents a line

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First three words of each advertisement will be set in capital letters.

For display of any advertisement under the above classified headings see sizes and rates in column at right.

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POSITION WANTED—A first class foreman and electrician; has had two years' experience. Age 19. Address A. J. Wilson, Kahaka, Mo. 12-1-1

POSITION WANTED—By engineer who is a result getter. Time with present concern expires March, 1920. Records show an increase in efficiency and saving of fuel. Address W. C. Siple, Carson City, Mich. 12-15-1

HELP WANTED

WANTED—Refrigerating engineer in western Pennsylvania for 20-ton ice making and ice cream plant, electric driven throughout. Address Box 582, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

WANTED—An instructor in Mechanics at the University of Wisconsin for next semester, beginning about Feb. 10. Salary will depend on qualifications; maximum, $1900.00 for academic year. Apply with references and full information to Dean of Engineering College, Madison, Wis. 12-15-3

BOILER ROOM FOREMAN FOR POWER PLANT—Must have good working knowledge of boilers, combustion super-heaters, coal and ash handling machinery, automatic stokers, instruments, etc. Must be able to handle men and plan work in connection with repairs and maintenance for large industrial power plant in central Ohio. Address Box 583, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. 12-15-2

ENGINEER WANTED—To operate 300 h.p. steam pumping plant; should also have a good working knowledge of and be able to repair gasoline engines and do machine shop work; location, small town in Louisiana; married man preferred; references required. State salary expected. Write Florence Louisiana Co., Florence, La. 11-15-2

WANTED—First-class mechanical engineer capable of designing automatic machinery; one who already has a record of achievement and large and long experience in this line. An attractive salary will be paid. Address, with experiences. Deton, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. 11-15-2

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Large Set Rheostats, controllers, compensators, automatic starters and voltage regulators, both internal and external connections. 10 samples A.C., 25c. Particulars free. Charles Chittenden, Dept. E., 3024 Matthews Ave., Kansas City, Missouri.

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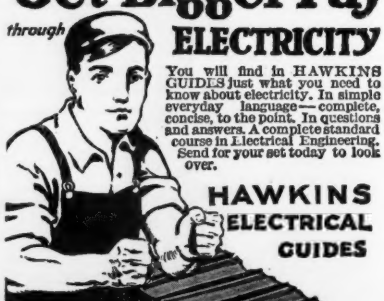

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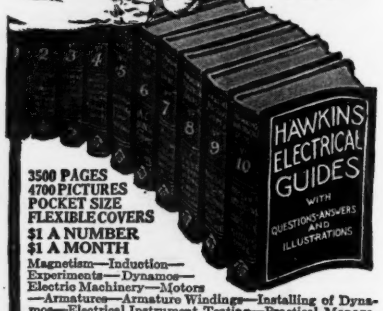

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THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electrical Guides (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

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A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf

PATENTS—C. L. Parker, formerly member Examining Corps, U. S. Patent Office. Patents, trade-marks and copyright. Handbook for inventors sent upon request. McGHl Bldg., Washington, D. C. tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 622 F St., Washington, D. C. Established 1883. I make an examination and report if a patent can be had and the exact cost. Send for full information. tf

SALESMEN AND AGENCIES

WANTED—Agents throughout the United States to handle the best pipe thread and gasket compound on the market today—Elastic—Non-Hardening. Will retain its strength under the most sudden temperature changes, from that of super-heated steam to below zero degrees. Big opportunity, liberal commission. Utility Supply Company, 329 N. Fourth St., Philadelphia, Pa. 12-15-2

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial to put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield. O. tf

The manufacturers of the most efficient coal-burning device on the market desire the services of local sales engineers. The apparatus is sold by written contract guaranteeing 70% overall efficiency of the fuel burned. Commission basis. Fine opportunity for live salesman. Address Box 566, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. tf

AGENTS WANTED—Throughout United States, for simplest, most durable, effective, inexpensive boiler flue blower; big market available, large commisions. Address Box 580, Power Plant Engineering, 37 So. Dearborn St., Chicago, Ill. 11-15-2

WANTED — Distributors in unoccupied territory for Pyrobond Fusible Fire Brick Binder. Send for circular and sample. Chestnut Ridge Corp., 7-11 W. 45th St., New York, N. Y.

SALESMEN AND AGENCIES

A JOB WITH A FUTURE FOR A PLANT ENGINEER

There is a big library, dining and office table factory in a Michigan city where a young man thoroughly versed in efficient operation of a power plant can find a good job with good pay. The town will make a good home for a family, because it is one of the cleanest towns in Michigan, politically and in every other way. The plant consists, in the main, of two 250-hp. Wickes water tube boilers and a 500-hp. Corliss engine, located in a brick building between the two wings of the factory. Clean as a whistle and we want that sort of a man to run it." Address Box 584, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. 12-15-1

WANTED

Second-hand exhaust feed water heater, 300 h.p., open type. Box 288, Maysville, Kentucky.

BIDS WANTED

NOTICE TO CONTRACTORS

Notice is hereby given that the City Clerk of Iowa Falls, Iowa, will receive sealed bids until noon of the 1st day of December, 1919, for the drilling of a well at the City Water Works, in the city of Iowa Falls, Iowa.

Bids to include both 10 and 12-inch wells and casings. Said bids will be acted upon at a meeting of the City Council to be held at Council Rooms in the City Hall, on the 1st day of December, 1919, at 8 o'clock p. m.

A certified check in the sum of $300 must accompany each bid as a guarantee that the bidder will enter into contract for doing the work, in case their bid is accepted. Work to be begun within 30 days after contract is signed, and diligently prosecuted until completed, depth of well and supply of water to be determined by the City Council. The city reserves the right to reject any and all bids. Casing to consist of Standard Black pipe.

J. O. GREGG,
City Clerk.

EQUIPMENT WANTED

WANTED
Two return tubular boilers.
66"x18' or 72"x16'
125 lbs. working pressure.
Hartford Insurance Co. Inspection.
CAIRO ICE & COAL COMPANY,
Cairo, Ill.

MISCELLANEOUS

The Power Plant Records and Analysis Number

of POWER PLANT ENGINEERING sells for one-half of a dollar, the same price as the specialized January first issues of previous years.

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2—500 hp. Keeler water tube, 160 lbs., 2 yrs.
2—100 hp. Keeler water tube, 160 lbs., 2 yrs.
4—350 hp. B. & W. water tube, 180 lbs., 12 yrs.
2—250 hp. Keeler water tube, 160 lbs., 2 yrs.
1—250 hp. McNaull water tube, 125 lbs., 6 yrs.
1—230 hp. B. & W. water tube, 150 lbs., 12 yrs.
2—200 hp. Heine water tube, 150 lbs., 5 yrs.
2—100 hp. Heine water tube, 175 lbs., 10 yrs.
8—72x18 H. R. T. suspended, 150 lbs., 2 yrs.
5—72x16 H. R. T. brackets, 125 lbs., 6 yrs.

ENGINE GENERATOR SETS

2—500 kw., 250 volts, d.c. comp. engine, non-cond.
1—300 kw., 250 volts, d.c. comp. engine, non-cond.
1—150 kw., 250 volts, d.c. simple engine.
1— 60 kw., 250 volts, d.c. simple engine.
1—150 kw., 2300 volts, a.c. simple engine.
1—125 kw., 2300 volts, a.c. simple engine.

TURBO GENERATOR

1—1000 kw. Westinghouse turbo generator, 2300 volts, 60 cycle, 3 phase.

CONDENSERS

2—2000 sq. ft. Worthington surface condensers, complete with pumps and auxiliaries.
1—Le Blanc jet type turbo driven, capacity, 18,750 lbs. steam per hour.

R. L. BAKER

Edison Bldg. Randolph 1456 Chicago

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Exceptional Power Plant Offering

Due to electrifying six plants of the City Ice Delivery Co., Cleveland, Ohio, we have purchased and offer for immediate sale Boilers, Engines, Pumps and other machinery as follows:

BOILERS
Return Tubular

	Lbs. Steam	Hp.
2—72x18 Hand fired	85	150
3—72x18 Murphy stokers	125	150
2—72x18 Murphy stokers	100	150
3—72x18 Murphy stokers	105	150
4—72x18 Murphy stokers	125	175
1—66x16 Hand fired	80	100
1—60x18 Hand fired	80	90

Water Tube

	Lbs. Steam
2—133-hp. B. & W. hand fired	100
1—200-hp. Geary Heine type	150
1—275 hp. Sterling	150
1—400-hp. Sterling high pressure	160

CORLISS ENGINES

Complete with balance wheels and outboard bearings, no belt wheel.
1—18x42 Right-hand Atlas.
2—22x42 Left-hand Atlas.
1—26x30 Great Lakes right-hand.
1—26x42 Filer & Stowell right-hand.
1—22x48 Featherstone left-hand.
1—22x42 Hamilton right-hand.
1—24x48 Lane & Bodley left-hand belt drive.
1—20x42x48 Murray right-hand heavy duty rope drive.

PUMPS
All Duplex and in fine condition

1—4½x5x8
3—8x10x8
2—8½x8½x5
1—8½x8½x5
2—6x6x8
1—8x8x8
1—6x4x7
1—6x4x8
6—7x4½x8
1—8x8x10
1—8x7x13
2—10x8½x13
1—12x8x13
1—12x8½x13
1—8x10x12 vacuum pump

AIR COMPRESSORS

3—Westinghouse 9½x9¼x10.
1—New York 7x7x8.
2—Westinghouse 11x11x11.
1—Weir 10x9x14.

VERTICAL ENGINES

1—6x6
1—6x8
1—7x7
3—8x8
1—8x10 double
1—8x12 side crank horizontal

MISCELLANEOUS

Filters and evaporators.
Bundy steam and oil separators.
1—Russell engine direct connected to water pump, air compressor and vacuum pump combined.
1—Overhead crane—hand power.
Condensing coils.
Piping.
Valves.
1—13 3/16x28 Arctic vertical ammonia ice machine and 21x22 Arctic Corliss engine.
480—300-lb. cans—11x21x44.

WIRE OR WRITE FOR PARTICULARS.

The Cleveland Belting and Machinery Co.
1524 University Rd. Cleveland, Ohio

For Sale

Twenty-ton refrigeration machine, Wolf type, steam driven, can be driven by belt. One Ice Tank; 88 300-pound cans, capacity 7 to 8 tons; one 60-h.p. return tubular boiler; 1 150-h.p. water tube boiler, heater, pumps and plant equipment. Closing down our plant, will sell at a reasonable price, machinery right size for ice cream maker. Machinery in good working condition. Address Box 572, Care Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

For Sale

2—136 H.P. B. & W. Water Tube Boilers, eight tubes wide, nine tubes high, single drum, Kelly shaking grates, full cast iron fronts; price, $500.00 each.

2—250 H.P. B. & W. Water Tube Boilers, double drum, full cast iron fronts, Martin shaking grates; price, $1000.00 each.

1—56 x 16 Freeman Fire Tube Boiler, with full cast iron fronts, standard grates; price, $200.00.

This equipment has recently been taken out of service and is in good condition. If interested, communicate with **DODGE MFG. CO., Purchasing Dept., Mishawaka, Ind.**

FOR SALE

Electric lighting outfit, consisting of 4-HP. Clark Upright Steam Engine, 2½-K.W. generator, 1500 R.P.M., 115 Volt D.C., complete with back connected rheostat. Used only short time. Will sell cheap. DAVIS-KANKAKEE CO., Aurora, Illinois.

For Sale

FOR SALE—WESTINGHOUSE GAS ENGINE; size 11x12; also Westinghouse belt driven generator, 125 volts, 25 kilowatt, with one switch board complete. Price $1000. Can be seen in operation at The Hein Company Power Plant, 34 Isabella St., N. S., Pittsburgh, Pa.

For Sale

1 Westinghouse A.C. Generator, 100 K.W., 2400 volt, 3 phase, 60 cycle, 900 r.p.m., serial No. 698817, together with 2 K.W. Exciter, rheostat, etc.

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1—400-kw. G. E., Type M. P., 250-v., 120 r.p.m., d.c. generator; direct connected to 18 and 36x42 tandem compound Corliss engine.

1—75-kw. G. E., Type M. P., 250-v., 250 r.p.m., d.c. generator; direct connected to 12 and 14x14 Atlas high speed steam engine.

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1—28x30-18x30, 2400 cu. ft. per minute, 100 lbs. pressure Sullivan Class WB-2 steam-driven air compressor.

1—18x20-12½x20, 900 cu. ft. per minute, 100 lbs. pressure Sullivan Class WB-2 steam driven air compressor.

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1—18x10x12 Dean Duplex Underwriters Fire Pump; 1,000 gallons per minute.

1—18x10x12 Fairbanks-Morse Underwriters Fire Pump; 1,000 gallons per minute.

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1—200 hp. Triumph, 220-v., 500 r.p.m., d.c. motor.

Water Heater

1—800 hp. Webster water heater.

Coal Conveyor

1—Jeffrey Coal conveyor and crusher.

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ONE COMPLETE Boiler Plant—300 h. p., 2 Scotch Marine boilers; complete with all pipes, valves, fittings, stacks, $2500. **J. F. DONAHOO CO.**

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Kw.	Generator	Engine	Price
200	Wghse.	Buckeye	$5500
160	G.E.	Harrisburg	4500
150	Ridgway	Ridgway	4250
150	Wghse.	Wghse. gas	5000
125	Wghse., 3 wire	Chand. Tay.	3000
100	G.E.	Ridgway	3000
75	Wghse.	Wghse. gas	2500
75	Ridgway	Ridgway	2000
75	G.E., 3 wire	Skinner	2500
75	Wghse.	Harrisburg	1800
62½	G.E.	Ames	1650
50	G.E.	Brownell	1000
50	Allis-Chal.	Chand. Tay.	1250
50	C.W.	Front	1000
40	Ridgway	Ridgway	1250
35	Northern	Ide	1200
30	G.E.	Harrisburg	1000
115	W.E.	Russell 4 v.	2500
100	Wghse., 3 wire	Erie	3000
100	G.E.	Skinner	3000
100 (2)	Sturtevant	Sturtevant ver.	2250
20	W.E.	Vertical	550

125-VOLT D.C. UNITS

Kw.	Generator	Engine	Price
150	Sprague	Harrisburg	$2750
125	G.E.	Ridgway	2500
100	Wghse.	Skinner	2000
75	C.W.	Ames	1650
2— 75	G.E.	Ridgway	1750
75	G.E.	Bruce McB gas	2500
65	Garwood	Harrisburg	1200
50	C.W.	Ames	1000
50	G.E.	Harrisburg	1200
40	Sturtevant	Sturtevant	850
35	Bullock	Ridgway	900
15	Cr.	A. & S.	450
15	Sprague	Ames	550

220-250-VOLT GENERATORS

Kw.	Make	Speed	Price
225	G.E.	425	$3200
2—150	Ridgway	550	1200
45	G.E. type D.L.C.	775	475
37½	Lincoln 3 wire	850	450

110-125-VOLT GENERATORS

Kw.	Make	Speed	Price
200	Bullock	300	$3000
150	G.E.	550	1400
100	Bullock	550	950
85	G.E.	790	750
60	Wghse.	800	600
45	G.E.	800	475
32½	G.E.	700	300
20	G.E.	1250	200

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Kw.	Generator	Engine	Price
675	G.E.	Ball-Corliss (new)	$21000
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400	Wghse.	Ball 4 valve	12000
300	Al. Chal.	Parsons turbine	9000
250	Wghse.	Wghse. ver.	4000
156	Wghse.	Parsons turbine	
150	G.E.	American Ball	3250
150	Wghse.	Chandler & Tay.	
2—125	Al. Chal.	Buckeye heavy duty	3500
125	Wghse.	Parsons turbine	3000
110	Al. Chal.	Bates ver.	2800
100	Ridgway	Ridgway	2500
100	Cr. Wh.	Engine type gen.	1800
75	Wghse.	Russell	2100
50	Wghse.	Harrisburg simp.	1900
36	G.E.	Fleming	2100
35	W.E.	Sturtevant	2000

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Double pipe ammonia condensers, 5 sections, 12-pipe high, 60-ton capacity. Good as new. Must remove these condensers for room. Address Box 581, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

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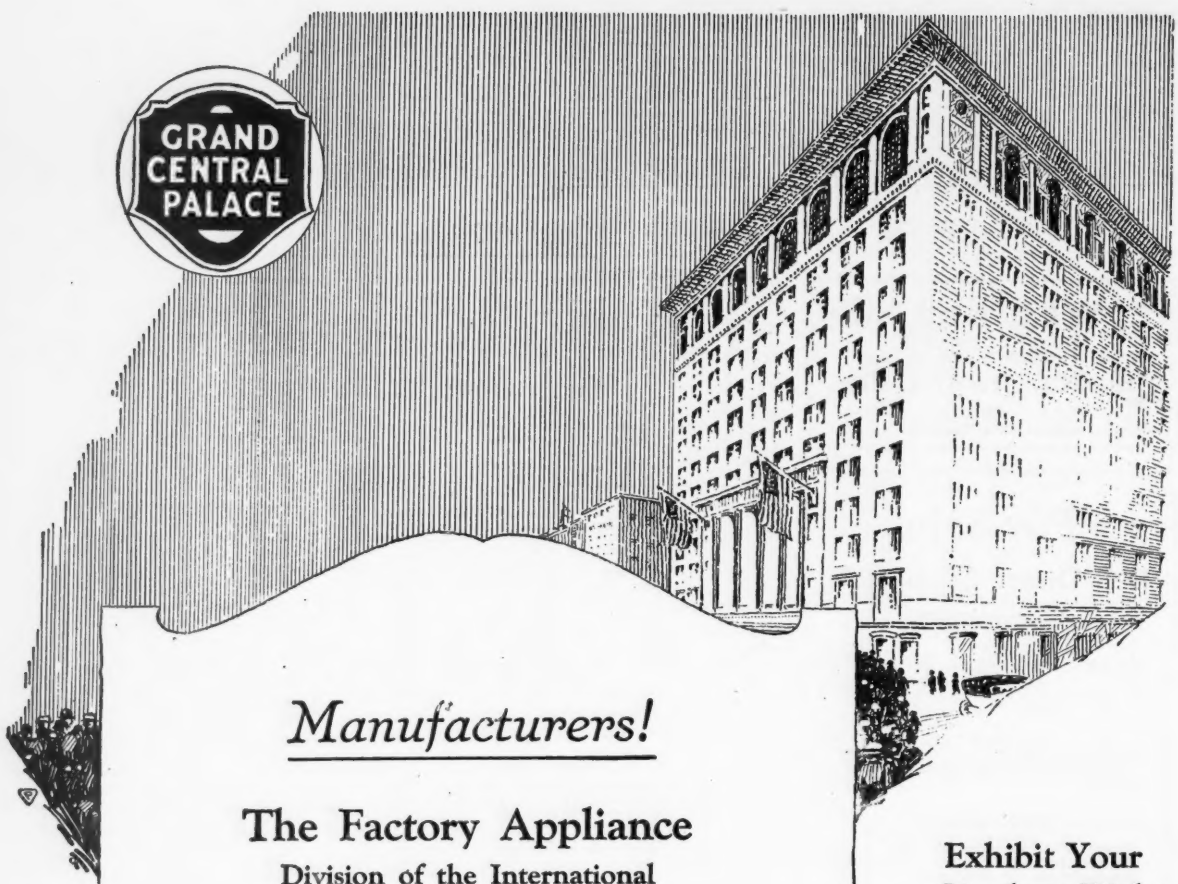

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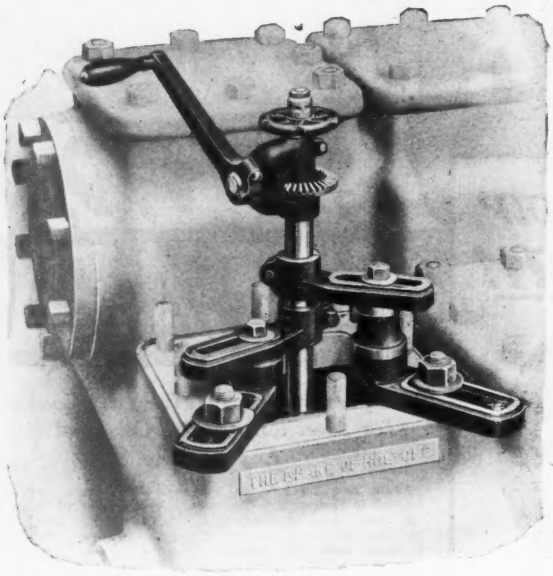


Mr. Engineer:

Do your pump valves leak?

It has been proven that pumps which have been in operation for only a short time will use 50 to 100% less steam after the seats have been refaced with

The Dexter Pump Valve Reseating Machine

This machine is made in styles and sizes to fit all types of duplex, triplex, single cylinder, plunger, boiler feed, vacuum, underwriter, mine and general service pumps regardless of the location of their seats.

This outfit is as simple and positive in operation as the Dexter Globe Valve Reseating Machine.

If you use pumps you need one.

Write now for our Catalog T-19.

The Leavitt Machine Co.

ORANGE, MASS., U. S. A.

Here's a Chance to Economize

With wages increasing and the cost of production constantly soaring, it seems as though the chances to economize are few and far between. However, an opportunity to save much labor and reduce expenses will appear in the form of

FORBES Pipe Cutting and Threading Machine

"The Man-Power Saver"

if you have pipe cutting or threading to do.

One man can run any Forbes Machine, whether it is operated by hand or electric power. It is moved right to the job and if the pipes are extra heavy, a trolley can be used over the machine.

A saving of the labor of from one to four men will be effected. The first cost is moderate and the upkeep is almost nothing.

Make use of this opportunity to economize and send for our catalog at once. An early order will assure prompt delivery.

CURTIS & CURTIS CO.

53 Garden Street Bridgeport, Conn.

Do you know that—

a hot surface of this measured area wastes 127½ pounds of coal each year?

Few people realize that this condition exists if the temperature within a pipe, for example, is 230° Fahrenheit (the temperature of steam at 5 lbs. pressure) and the temperature of the air surrounding the pipe is 70° Fahrenheit—a very moderate condition.

If it is steam heat—

Size of steam pipe.	*The waste in dollars per year per linear foot of pipe, coal at $10.00 per ton, 1 lb. steam pressure—temperature of air around pipe 70° Fahrenheit.*
2"	$ .95
3"	1.40
4"	1.80
5"	2.20
6"	2.65

Read the remedy to the right.

If it is hot-air heat—

Size of hot-air pipe.	*The waste in dollars per year per linear foot of pipe, coal at $10.00 per ton. Air in pipe 150° Fahrenheit—air around pipe 70°.*
8"	$1.00
9"	1.10
10"	1.25
12"	1.50

Read the remedy to the right.

If it is hot-water heat—

Size of hot-water pipe.	*The loss in dollars per year per linear foot of pipe, coal at $10.00 per ton. Water in pipe 180° Fahrenheit. Air around pipe 70° Fahrenheit.*
2"	$ .67
3"	1.00
4"	1.25
5"	1.55
6"	1.85

Read the remedy to the right.

EVERY hot surface radiates heat. If this heat goes where it is not required, it is wasted and so is the coal that was burned to produce it. Opposite are some actual figures on such wastes—based on average conditions in American homes like yours.

The Remedy

Insulation correctly designed, manufactured and applied will reduce heat loss from hot surfaces as much as 90%. Efficient insulation must be made of material that does not conduct heat and that combines with this property the necessary strength and durability.

Johns-Manville Asbestocel Insulation has all these desirable characteristics. It is made for application to steam, hot-air and hot-water systems. Other Johns-Manville Materials: Sponge felt and 85% Magnesia for high pressure steam, Anti-Sweat and Zero for cold water, Combination Built-Up for Brine and Ammonia.

Inspect your heating plant for exposed hot surfaces on pipes, boilers and heaters, and for sections not *properly* insulated.

Have your steamfitter apply Asbestocel to pipes, boilers or heaters, sealing all cracks and joints, finishing boiler and heater surfaces with Johns-Manville Insulating Cement. In this way you will save the added coal that must be burned when there is waste.

H. W. JOHNS-MANVILLE CO., New York City

10 Factories—Branches in 63 Large Cities

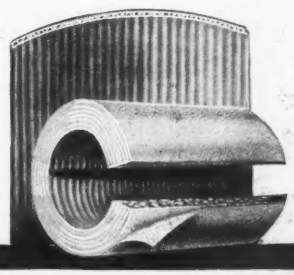
Unfortunately many materials used for "covering" pipes are not efficient heat insulations — not only because their constituent materials are inferior, but because their construction is incorrect or faulty.

To aid you in buying, Asbestocel is shown here in two forms:

In sectional form for fitting around steam and hot-water pipes.

In flexible roll form, for fitting around hot-air pipes, heaters, etc.

We recommend Asbestocel rather than air cell because of its construction, viz: the cells run around the pipe—not lengthwise, thus preventing circulation of air.



JOHNS MANVILLE SERVICE COVERS THIS CONTINENT

Through—

Asbestos

and its allied products

INSULATION *that keeps the heat where it belongs*

CEMENTS *that make boiler walls leak-proof*

ROOFINGS *that cut down fire risks*

PACKINGS *that save power waste*

LININGS *that make brakes safe*

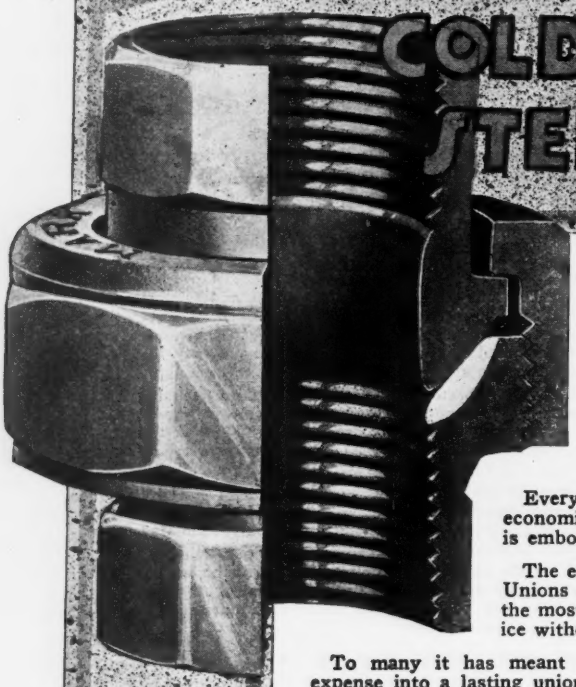
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Serves in Conservation

MARK

A MARK OF QUALITY

COLD DRAWN STEEL UNIONS



The union of Scientific and Mechanical perfection.

Every factor in the practical and economical transmission of power is embodied in the Mark Union.

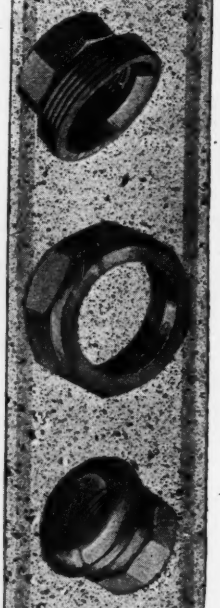
The engineer who specifies Mark Unions can rely on them to stand the most severe conditions of service without leakage or corrosion.

To many it has meant turning a constant union expense into a lasting union service.

The brass seat, being an integral part of the union (fused to the steel) assures a permanent, leakproof joint.

The rolled steel from which it is cold drawn contracts and expands with the same coefficient as the pipes it unites.

Send for a sample union and give it a thorough test on the line that's causing you the most trouble. Send for it now while you are thinking about it, and know what real union service is.



Mark Mfg. Co.

1908 Dempster Street
Evanston, Ill.

General Offices: 2111 Conway Bldg.
111 West Washington St.
CHICAGO, ILL.

District Offices in all Principal Cities

FOR HIGH & LOW PRESSURE

Efficient on All Services

It's the joints that trouble the engineer, not the pipes. Under the strains due to expansion or contraction the joints give, and leaks develop.

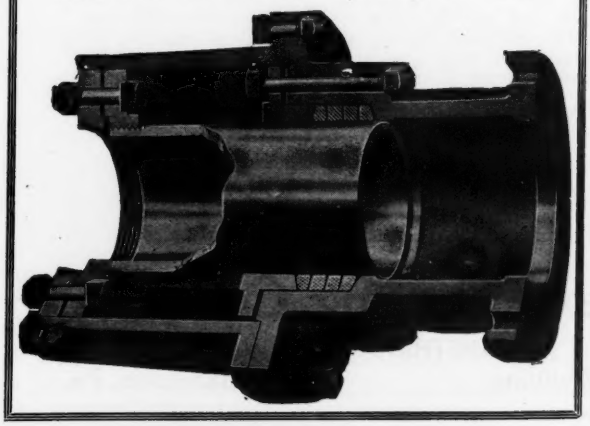
HOWARD GUIDED EXPANSION JOINTS

abolish such troubles on the lines. They take up the lineal changes in the pipe. The inner slip tube of bronze takes care of the distortion strains and keeps alignment rigid. It cannot rust against the packing.

Efficient and **dependable** for high or low pressure steam, hot water, gas, air, chemicals or oil. Joints made in any desired size.

Described fully in our new catalog X-J-2. Write for a copy.

Howard Iron Works Buffalo, N. Y.



Williams' "Vulcan" Chain Pipe Vise

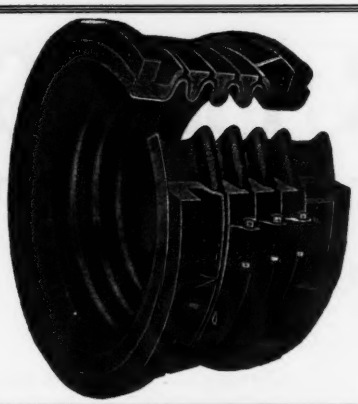
WILLIAMS' "Vulcan" Drop-Forged Chain Pipe Vises are the only tools of their class made entirely of wrought steel. They are unbreakable, rapid in action and attachable anywhere—any handy bench or post will serve.

The compact design of these wrought Vises is in strong contrast to the bulky and clumsy cast product previously used—their light weight is an unusual feature in tools of their capacity. They are carried in stock in three sizes, for ⅛ to 8-inch pipe. Carried in stock by your dealer. Ask for Booklet.

J. H. Williams & Co.

"The Drop-Forging People"

81 Richards Street, Brooklyn, N. Y.
81 South Clinton Street, Chicago, Ill.
81 Vulcan Street, Buffalo, N. Y.



BADGER SELF-EQUALIZING EXPANSION JOINTS

Will permanently prevent leakage, looseness, and fractures, due to changes in temperature in steam, air, water, and other pipe lines.

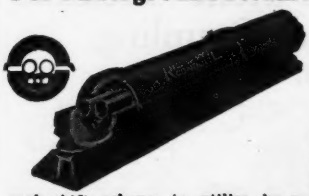
Write for our new book today

E. B. BADGER & SONS CO.

101 Park Avenue
NEW YORK CITY

75 Pitts Street
BOSTON, MASS.

For Underground Steam and Hot Water Pipes the SIMPLE RIC-WIL METHOD



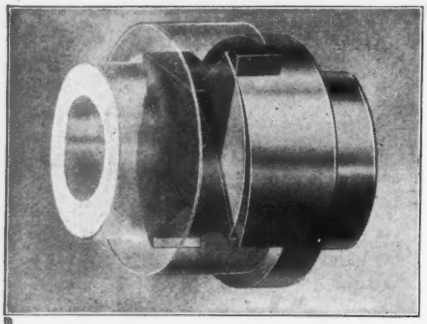
appeals to the man with common sense. It is a clean-cut, complete and ruggedly practical system of pipe insulation—not a makeshift scheme to utilize by-products. It is efficient up to 90 per cent. which makes it economical. It is impervious to decay or deterioration, which makes it permanent. But best of all, it is simple and practical—the kind of material that highly trained technical men and practical operating engineers both approve. Bulletin No. 1 explains RIC-WIL simplicity and other features. Free.

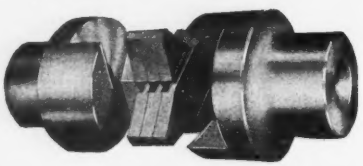
THE RIC-WIL COMPANY **CLEVELAND, O.**

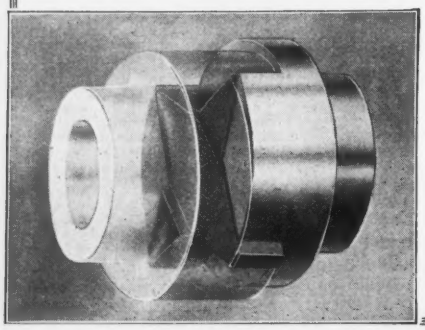
"NATIONAL" Welding-SCALE FREE Pipe

Another "NATIONAL" achievement described in detail and illustrated in "NATIONAL" Bulletin No. 7 Manufacture and Advantage of "NATIONAL" Welding-SCALE FREE Pipe

NATIONAL TUBE COMPANY **PITTSBURGH, PA.**







UNIFLEX
"Wherever Shafts Meet"
COUPLINGS

"Admittedly Superior"

is the verdict of the many manufacturers of pumps, generators, etc., who have tested Uniflex Couplings. They like to see their equipment coupled up with Uniflex because they know it means longer life, no loss of power, and perfect satisfaction in year in and year out service.

Do your part and do not let a mere difference in first cost prevent you from reaping the big dividends an investment in Uniflex Couplings will bring you in increased efficiency, longer life and decreased operating costs of the machinery they couple.

Uniflex Couplings pay many times over in the saving on couplings alone. The rest is clear profit.

Write today for full particulars on the wonderful new, approved mechanical principle of this superior coupling. Remember every Uniflex is

"Guaranteed for the Life of the Machine"

Uniflex Coupling Company

DISTRIBUTORS

Lafayette Building **Philadelphia, Pa.**

PITTSBURGH FOR PIPING

and you get results in your Power Plant

Pittsburgh Piping and Equipment Co.

MANUFACTURERS AND CONTRACTORS

New York Cleveland Chicago Pittsburgh San Francisco Birmingham

KARGE

FLEXIBLE FRICTION COIL COUPLINGS

enable power to be transmitted at any angle. Shafting equipped with **Karge Couplings** may be carried around corners or over or under obstructions without loss of power. Dis-alignment of shafting is no obstacle. Easy to apply, and acts as a cushion against the shock of quick starts.

Write for Bulletin

The Karge-Baker Corporation
PHOENIX, N. Y.

GRUNDY Patent Flexible Insulated Coupling

An Ideal Connection

for use between ends of shafting or for connecting motor to varied types of machinery. No complicated parts—no dangerous projections. Dependable and durable in service. Will transmit more horse power than any other flexible coupling of equal diameter. Write for booklet.

Charles BOND Co.
617 Arch St.
Philadelphia, Pa.

A Double Service In One DART Union = 2

One DART **Union** that lasts as long as TWO ordinary unions saves MORE than half of the union expense. It saves the **time** in buying, applying and the **time** between —when ordinary unions are often leaking before replacement is made.

Look at the DOUBLE bronze seats on the DART—double service **at the point where the life of unions is usually determined.**

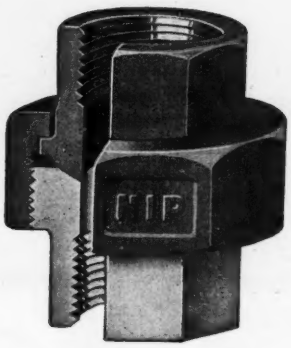
This bronze-to-bronze DART feature is one of the reasons why they last so long, no matter what the service—whether it requires holding without corroding, or frequent making and breaking of the joint.

Ask us to let you try one at our expense.

E. M. Dart Manufacturing Company, Providence, R. I.

The Fairbanks Company, Sales Agents. Canadian Factory, Dart Union Company, Ltd., Toronto

The Nip Union

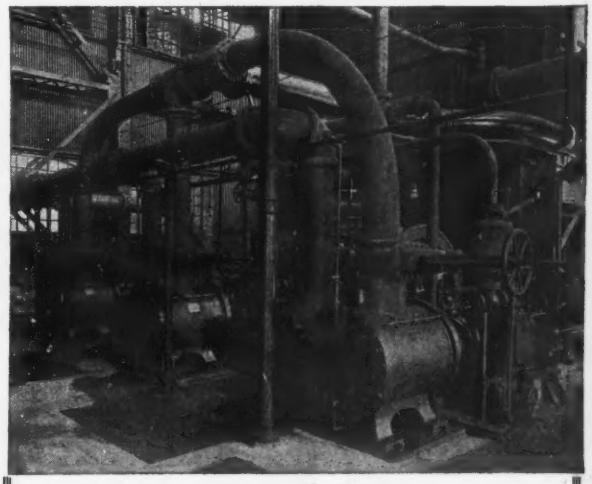


The Nip Union is one of the simplest unions made, there being only three parts. The ring and bottom are made of heavy Malleable Iron and the thread end of brass. The brass to iron seat eliminates the use of gaskets and the two metals make a much better joint than one made of the same metal. The threads are all brass to iron and will not corrode. The brass to iron seat makes it possible to re-connect it many times without injury.

The Nip Union is only one of several different styles of union illustrated in our new 1919 catalog "R."

Copy Sent On Request

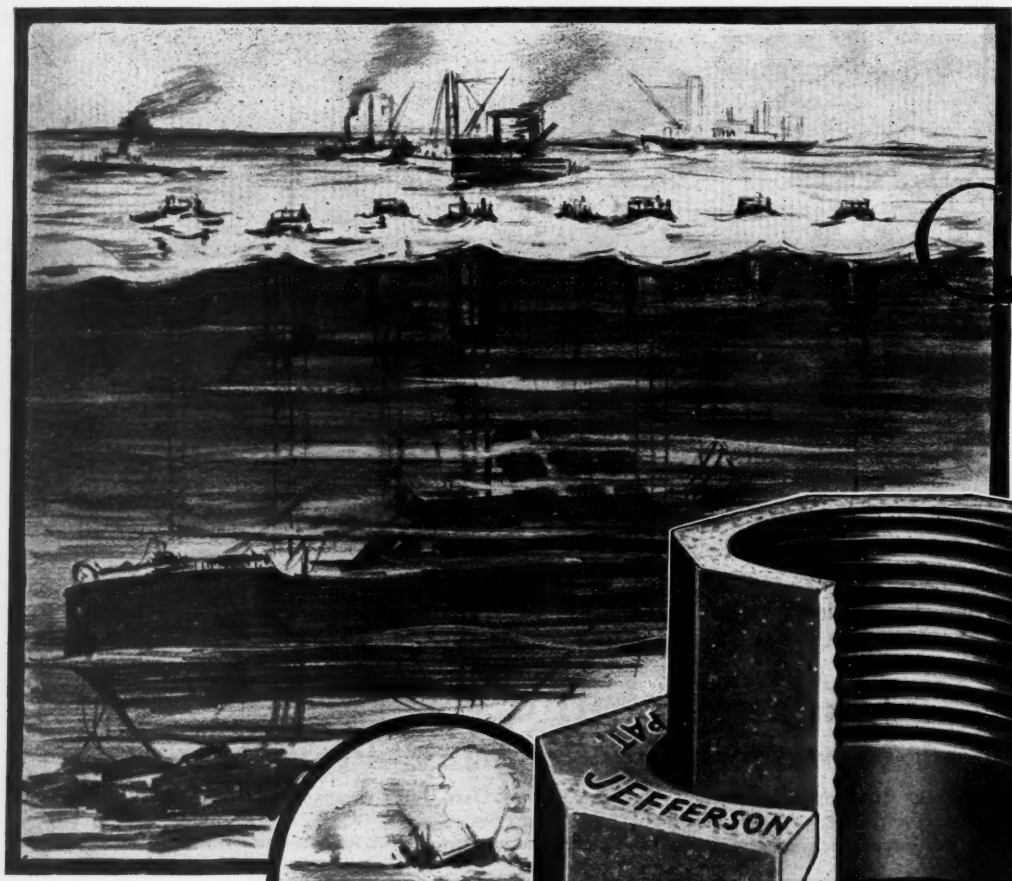
The Kelly & Jones Company
Greensburg, Pa.



Complete Piping Systems
Our Specialty

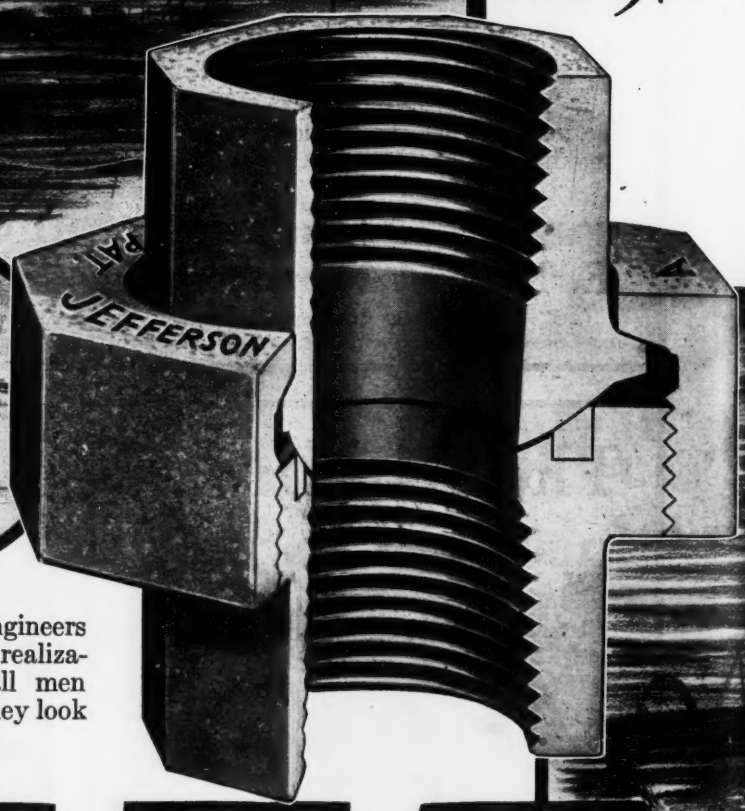
Pittsburgh Valve, Foundry and Construction Company
Pittsburgh, Penna.

Engineers Founders Pipe-Fitters Machinists



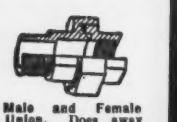
A

"Look for the Name on the Nut"



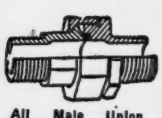
Surpassing Realities—

beyond the imaginings of poets and novelists—are the things of steel and magic power built by engineers and scientists. Jefferson Unions are a realization of that ideal in union service that all men desire, some claim, but all may obtain if they look for the name Jefferson on the nut.



Male and Female Union. Does away with a nipple and makes a short connection.

Jefferson Flange Union. Brass-to-iron ball joint. Made in eighteen sizes, from ⅛ to 12 inches.



All Male Union. Saves two pipe joints between two female threaded parts.

Jefferson Swing Union. Allows widest variety of connections, from slight offset up to 90 degrees.

JEFFERSO

Miracle of Modern Engineering Skill

Like the other modern mechanical miracles performed in the air, on the earth, and in the depths, the raising of ships waited on the performance of many little miracles in the perfection of seemingly insignificant parts.

Where power plants, in ships tossing on the waves, pump air into hulls, far below, to overcome the crushing force of tons and tons of water, only the perfection of Jefferson Unions can hold against the multiplication of strains and stress.

Where salt air and water corrode, and where ships and crews must dodge between storms to keep the task, only the better metal, the brass-to-iron ball joint and the perfect threads of Jeffersons can give true union service.

Location of brass seat ring, away from pipe contents, the impossibility of injury from pipe ends and all other harmful influences, is a patented feature. Sloping shoulder and large play in the ball end is of assistance in connecting piping out of line. Standard pipe threads tapered to fit the pipe. Coarse nut threads for quick adjustment. Heaviest of its class made, and sold at reasonable prices.

Jefferson Quality, that withstands the tests of crucial services, extends itself into surpassing length of service under ordinary conditions.

Order from your jobber by the name, JEFFERSON, the only way to make sure of the most union service for the money.

Jefferson Union Company

31 Fletcher St. **Lexington, Mass.**

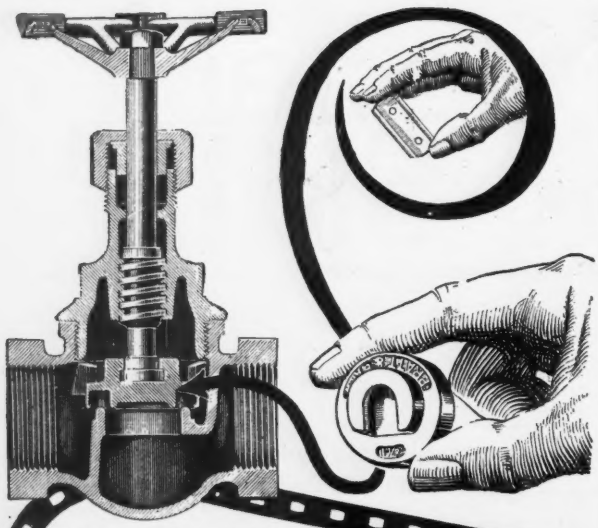
Union Tee, with union on the outlet. Made also with male end on outlet.

Jefferson Union Tee with union on the run. Has union end threaded either male or female.

Union Elbow, an economizer of the most pronounced type. Also made all female.

Union Elbow, all female. Takes place of straight union nipple and elbow. Made male and female.

ON UNIONS



Like Putting a New Blade in Your Safety Razor

When your safety razor blade is worn out you replace it with a new one—you don't throw the razor away.

The same principle applies to the Pratt & Cady *RENEWABLE* Disc Globe Valve. When the disc becomes worn from hard use you put a new one in its place—you don't throw away the entire valve.

In other words, you simply pay 25c for a new disc instead of $2.50 for an entire new valve in the 1-in. size. Then your Pratt & Cady "Renewable" is as good as new.

Old style razors and old style valves have to be discarded entirely when worn past use. Both are a dead loss.

Factories using Pratt & Cady Renewable Disc Valves cut down valve-costs to a minimum.

The operation of replacing a worn disc is a quick one, requiring only a few minutes. And the change can be made without removing valve from the pipe line.

An economy of this kind is worth thinking about. Many plants are saving big sums annually by putting in a "Pratt & Cady" every time an old-style valve goes bad.

Our Valve Book contains some facts that will interest you. We'll send you a copy on request. No obligation.

PRATT & CADY CO. INC.

Manufacturers of Valves, Asbestos Packed Cocks, Feed-Water Heaters, Hot-Water Generators, Hot-Water Service Heaters, and Power Pumps.

Boston Cleveland Hartford New York
Chicago Detroit Minneapolis Philadelphia
Pittsburgh San Francisco

Representatives in all large cities.

PRATT & CADY
RENEWABLE DISK GLOBE VALVES

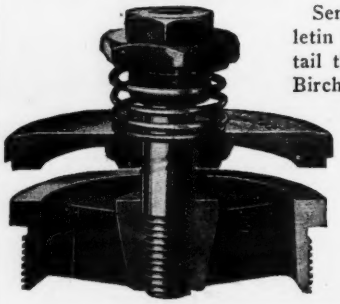
Continuous Satisfaction

The satisfactory service that **Birch Pump Valves** render users is evidenced by the letters received from large industrial concerns, mining companies, and great municipal plants, all reporting the same satisfactory service, and lasting qualities of

Birch Pump Valve

They can be depended upon to reduce slippage and leakage to a minimum.

The rubber seat rings are not cured in the valve, but separately, and securely locked in the valve body. Cannot warp, curl or break. There are no nuts or binder plates to work loose.

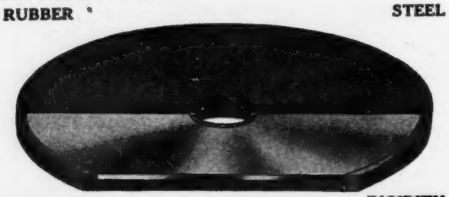


Send for our free bulletin which explains in detail the advantages of the Birch Pump Valve.

Birch Pump Valve Co.
1521-1523 Sedgwick St.
Chicago, Ill.

Voorhees Rub-Steel Valves

RUBBER STEEL

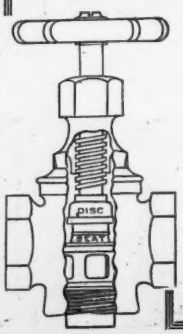


SEATING RIGIDITY

"The Valve with a Backbone"

VOORHEES RUBBER MFG. COMPANY
Jersey City New Jersey

Renewed Under Pressure



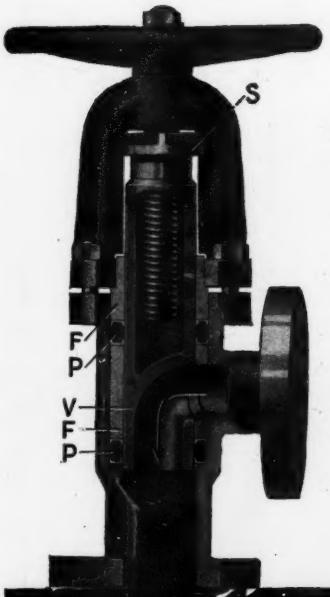
On no other valve made can the seat ring be renewed while the valve is under pressure except on

BASHLIN Valves

That is only one of the many superior features of the tight BASHLIN. We also make the BASHLIN "Y" or Blow-off Valve, Indestructible Check Valve and Trap Valve; also Faucets. Write for catalog J.

The BASHLIN Company
Warren, Pennsylvania, - U. S. A

Not Our Own Say So



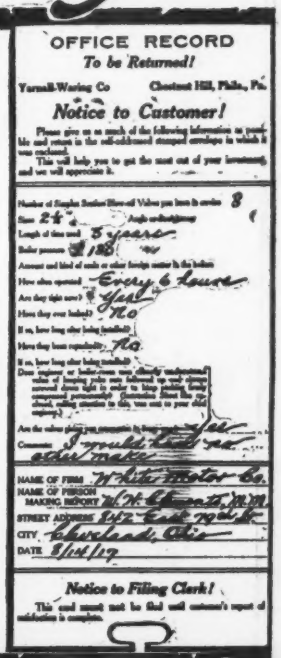
Of many hundreds of service record cards received recently from users of YARWAY (formerly the Simplex) Blow-Off Valve, 15% bore the voluntary statement under the heading of Comments:

"The Best Valve Made"

Other comments taken at random were:

"They are entirely satisfactory."
"First class Blow-Off Valve."
"No complaint to make.
"Entirely satisfactory."
"We like this valve 'best ever' since put in operation; have given better satisfaction than any other type or make previously used. Only one has been packed in the last two years."

These comments have come from the engineers of large manufacturing plants from coast to coast. You may check the judgment of more than 15,000 users by trying one for 60 days without cost. Send us today the size of your blow-off line and state whether angle or straightway, flange or screwed.


OFFICE RECORD
To be Returned!
Yarnall-Waring Co Chestnut Hill, Phila., Pa.
Notice to Customer!
Please give us as much of the following information as possible, fill out and return in the self-addressed stamped envelope in which it was enclosed.
This will help you to get the most out of your investment, and we will appreciate it.
Number of Simplex Boston Blow-off Valves you have in service 8
Size 24"
Length of time used 3 years
Boiler pressure 180
Amount and kind of scale or other foreign matter in the boiler
How often operated Every 6 hours
Are they tight now? Yes
Have they ever leaked? No
If so, how long after being installed?
Have they been repacked? No
If so, how long after being installed?
Does engineer or boiler-room man, directly responsible for blowing tubes, test thoroughly the proper amount drawn each time he blows, and is he properly instructed? Explain briefly the exact blowing operation to this man next to your duty engineer.
Are the valves giving you complete satisfaction? Yes
Comments I prefer this to any other make.
NAME OF FIRM White Motor Co.
NAME OF PERSON MAKING REPORT W. H. Gleason, M.M.
STREET ADDRESS 842 East 79th St.
CITY Cleveland, Ohio
DATE 8/24/17
Notice to Filing Clerk!
This card must be filed until customer's report of satisfaction is complete.

YARNALL WARING CO.
Penna. R. R. and Mermaid Lane, Chestnut Hill
PHILADELPHIA
CHICAGO NEW YORK PITTSBURGH

Rubber Pump Valves

Upon the valves depends, largely, the efficiency of the pump. Maximum efficiency is to be had only by using rubber pump valves specially designed for your particular conditions.

You will find it to your advantage to make use of our Engineering Service. Consult us in regard to your pumping requirements—the conditions the valves are required to meet.

This service is free. There is an USCO Pump Valve to meet every requirement.

To obtain this efficiency specify USCO Pump Valves. Made by the world's largest rubber manufacturer.

Investigate USCO Valves.

"The Right Valves for Any Pump."

United States Rubber Company

Williams Valves

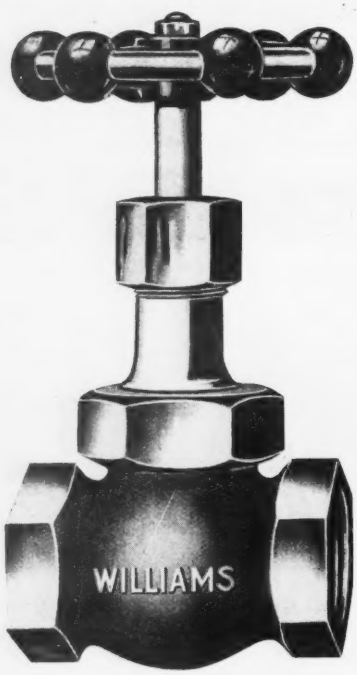
Guardians of the Pipe Lines.

Guarding Industry's Profits

When experts of acknowledged standing speak they command attentive hearing. In the science of combustion Joseph Harrington is regarded as a national authority. Because of his fame the United States Government, in the days of coal famine, made him Administrative Engineer for the State of Illinois. In Power Plant Engineering, June 15, 1919, Mr. Harrington said:

"In all cases it (coal) is the largest single item entering into the cost of steam or electricity."

It is, therefore, of prime importance that this costly product—steam—shall not be wasted. Steam is **money** in a vaporized form. Wasted steam is **money** in concrete form.



Williams Regrinding Valves, No. 107 is one of the Williams Superior types that has built the Williams reputation for long, dependable service throughout industry. Discs and seats extra heavy, special metal, machined for a **tight** bearing. Seat may be reground with a little oil and emery; a few moments' work, and the valve is like new. No extra discs ever required, making an important saving. Stem, extra heavy and strong, of best bronze. Will not bend or break. All threads engaged when valve is closed, preventing stripping or unequal wear. **Exclusive** feature with the **Williams.** May be repacked under pressure with absolute safety. Sustains 200 lbs. pressure easily.

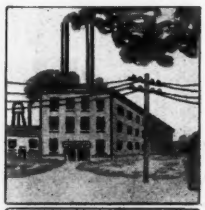
Scattered through the power plants are some hundreds of valves, large and small, with only one function to perform—**save steam.** A **good** valve does it, and is a **loyal dependable** servant. A bad valve is a profligate and should be scrapped.

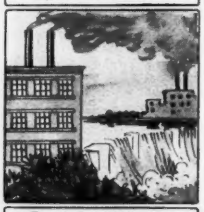
Williams Valves have a reputation maintained unblemished for many years. The qualities that make them **dependable** and **economical** are built into them, regardless of expense. **Every** valve must prove its worth under test before shipment. If it stands this test successfully there is no condition of actual service in which it will be found lacking.

Williams Valves never fail. Production never lags in plants protected by them. Profits are never turned into losses. Steam is **never** made at great cost only to be wasted. And because of these **reliable services** the name **"Williams"** on a valve is accepted by thousands of plants as **insurance** against **loss** and **trouble.**

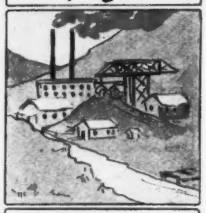
Williams Valves are made in many types, all conforming to the most advanced engineering practice. When our name is on a valve **it may be depended upon.**

Write for our free Catalog 10


Central Stations


Power Plants

Pumping Stations


Mines

Ships

The D. T. Williams Valve Co.

Cincinnati, Ohio

CRANE 72-INCH GATE VALVES

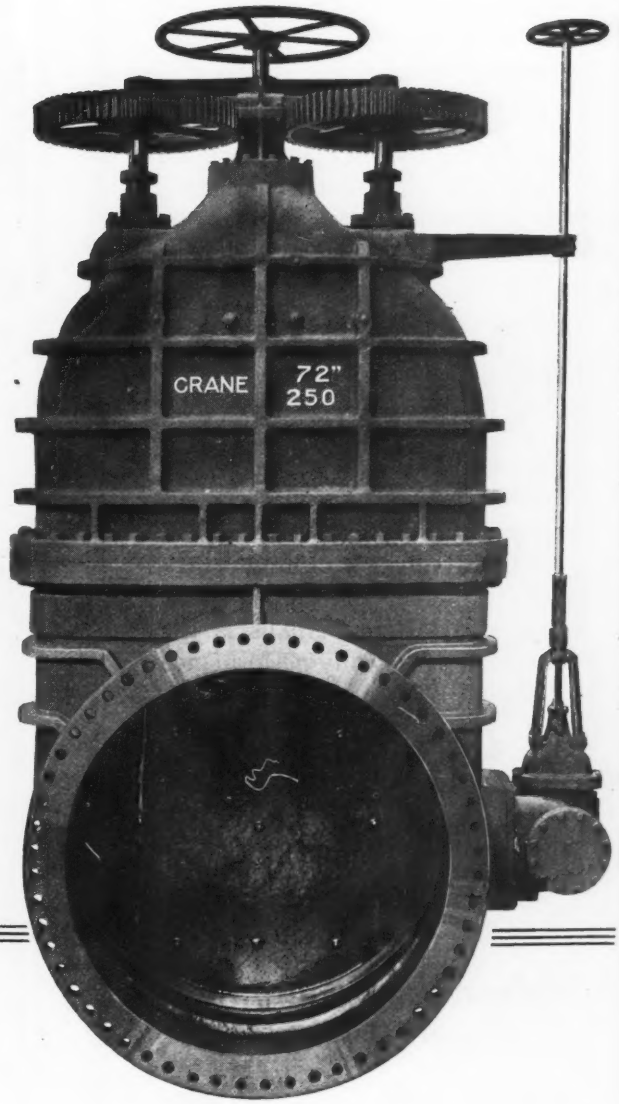
For Hydraulic Service

can be furnished with hydraulic cylinder or motor operated.

This big 72-inch Gate Valve is used under hydraulic working pressure of 125 pounds, after being tested to 250 pounds.

The massive construction of the valve makes this high working pressure possible with a large factor of safety.

This valve has two bronze spindles, upon which the huge gates (weighing 4½ tons) may be readily raised and lowered by the 42-inch hand wheel, operating in connection with the gears. The gates are bronze-faced and travel on bronze rollers on bronze tracks in the valve body.



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FOUNDED BY R. T. CRANE, 1855

CRANE CO.

836 S. MICHIGAN AVE.
CHICAGO

Works: Chicago and Bridgeport

CRANE, LIMITED—Calgary, Alb., Montreal, Que., Toronto, Ont., Winnipeg, Man., Vancouver, B. C.

Most valves look alike—but it's performance that counts

That's where Nelson Valves are strong in performance—in standing up.

It's easy enough to say that a certain valve is better than all others, but the valve you want—the one you need—is that valve that will day in and day out—unfailingly, do its work without a hint of trouble.

And that's the valve you get if it's marked **Nelson.**

Nelson Valves are constructed of close-grained castings correctly alloyed metals and finely machined parts only. In addition every piece is under careful, constant inspection. Here perhaps is the reason for the steady performance of Nelson Valves.

Our Reference Book on Nelson Valves is 156 pages of the latest valve information. You'll probably find a copy helpful to have around. Your name and address on a post card will bring it.

Nelson Valve Company

Chestnut Hill, Philadelphia

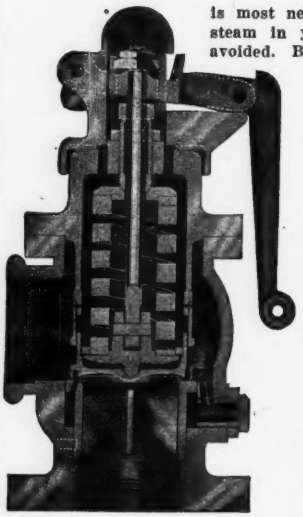
New York: 90 West St.
Pittsburgh: Jenkins Arcade.
Boston: 141 Milk St.
Chicago: 61 W. Lake St.
Cleveland: Rockefeller Bldg.
Washington: 710 14th St.
Minneapolis: Andrus Bldg.
San Francisco: Hearst Bldg.

Representatives in other large cities

NELSON VALVES—"A safe valve investment"

Boiler Thrift

is most necessary. Needless waste of steam in your power plant must be avoided. By attaching an



ASHTON Pop Safety Valve

to your boiler you will be practicing thrift in the most profitable way. It will lessen your coal bills, increase production and save both money and steam.

Relieves excessive steam pressure—avoiding disastrous accidents. Saves coal costs by preventing unnecessary blowoffs of steam. It is automatic in action—enduring in service—and once set cannot be tampered with.

There are other features of the ASHTON Valve worthy your attention. Let us send you full particulars.

Why Not Try One at Once?

The Ashton Valve Co.

161 First St., Cambridge, C,
Boston, Mass.

Branch Offices:
137 Liberty St., New York 318 W. Washington St., Chicago
503 Mission St., San Francisco

The Long Arm of the

Babbitt

—Adjustable—

SPROCKET RIM

with Chain Guide

spells "safety first" for men and materials. Somewhere there is an out-of-reach valve which must be closed quickly. Stop climbing that rickety old ladder and close the valve by chain.

The BABBITT fits any valve; installed with a wrench in five minutes.

Write for Catalog

BABBITT STEAM SPECIALTY CO.

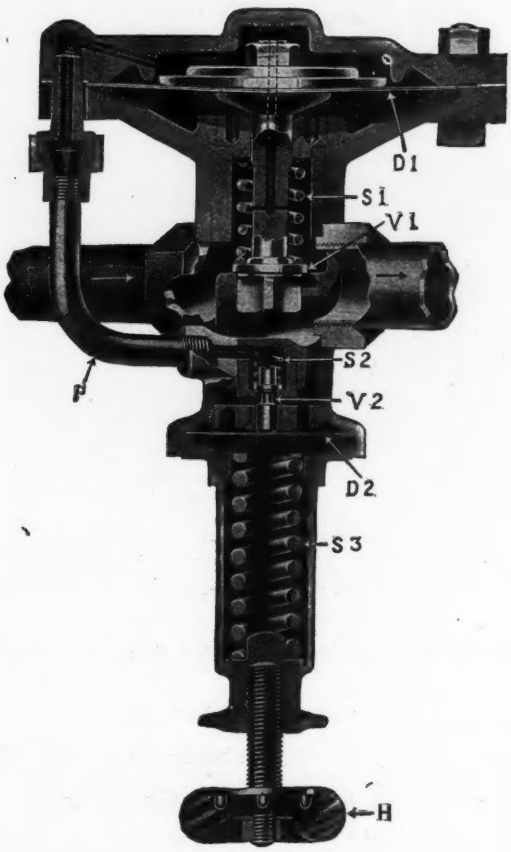
New Bedford, Mass.

Canadian Agents
Engineering Specialties Co., Ltd.
Toronto, Ont., Can.

Jenkins Bros.
600 W. Lake St., Chicago,
Western Distributors

93-41

Give Part of Your Work to the O-B Regulating Valve



Sectional View O-B Type F Regulating Valve—Patented

Once it is set for any reduced pressure you can go on with your other duties and forget an O-B Regulating Valve.

It delivers steam or air at the desired pressure accurately even though the initial steam fluctuates or the service demand varies.

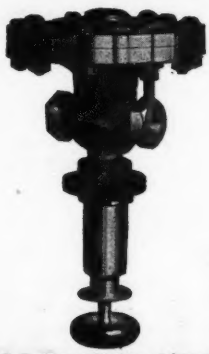
The O-B Regulator stays accurate. The controlling Valve (V-2) is protected from the full force of incoming, scale and dirt-laden steam.

All the mechanism is enclosed—no weights to be lost.¶

The mechanism is simple, so the parts are sturdy and the valve compact.

Use the Coupon

The Ohio Brass Company, Mansfield, Ohio



O-B Type F Regulating Valve—Patented. For steam or air.

The Ohio Brass Company,
Mansfield, Ohio.

Send your Regulating Valve booklet to me. This does not obligate me.

Name .....

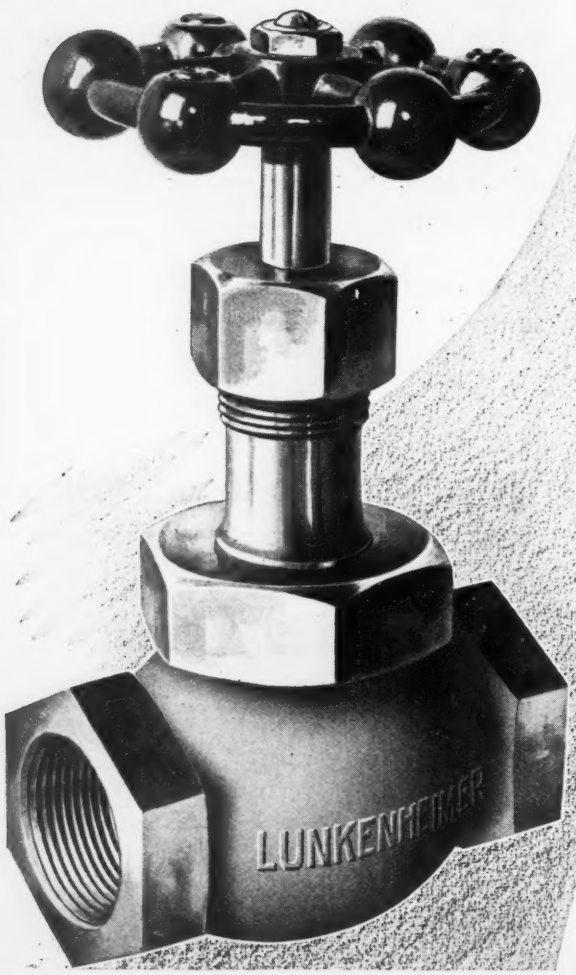
Company .....

Address .....

.....

P.P.E. 1219

LUNKENHEIMER PRODUCTS



To the user they need no introduction—their high quality, reliability and serviceability having made a lasting impression.

Others seeking the "better grade" of Engineering Specialties will find in those bearing the name

"LUNKENHEIMER"

that high quality of design, materials and workmanship which is synonymous of THE BEST.

"Lunkenheimer Products" embrace a variety of high-grade specialties for use on Steam Engines, Boilers, Locomotives, Steamships, Automobiles, Motor Boats, Airplanes, Tractors, etc.

Each device is designed for a particular purpose and will perform the functions for which it is intended, with a CERTAINTY that insures safe, economical and reliable service.

Leading dealers everywhere sell "Lunkenheimer Products."

Specify and insist on having the genuine.

Write for descriptive literature.

THE LUNKENHEIMER CO.

—"QUALITY"—

Largest Manufacturers of High Grade Engineering Specialties in the World

CINCINNATI

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32-17-44

ARMOUR uses 'JENKINS'

For Ten Years and more—

SOAP, STEAM, HOT AND COLD WATER CAUSTIC, LYES AND GREASE

—have passed through these 'Jenkins'

In the Armour soap factory in Chicago, Jenkins 2-in. Standard Brass Valves are used on various lines running to the soap boiling vats.

These valves are subjected to "hard usage." They are opened and shut many times by many people.

This service is typical of Jenkins valve performance everywhere.

Jenkins Valves are of all types and sizes to meet every requirement—they are known by the Jenkins "Diamond Mark"—at supply houses everywhere.

REG. U.S. PAT. OFF. TRADE JENKINS MARK Jenkins Bros

JENKINS BROS.

New York Chicago Boston
Philadelphia Montreal London

2080-J

Jenkins Valves

Sign of Value

Scott extra heavy pressure gate valve. For 250 lb. working pressure. Showing flanged end with by-pass.

No Service Is So Strenuous In the Power Field

as that imposed upon valves by the high pressures of modern practice.

Scott Valves

meet these conditions with an ease that constantly awakens engineering admiration.

It is a test that conclusively demonstrates their absolute reliability and durability.

There's a Sign of Value on Scott Valves to remind you to specify them when ordering.

SCOTT SPECIALTIES

Gate Valves	Safety Valves	Radiator Valves
Globe Valves	Relief Valves	Hot Water Valves
Angle Valves	Throttle Valves	Back Pressure Valves
Check Valves	Stop and Check Valves	Hose Valves

Scott Valve Mfg. Co.

formerly Roe Stephens Mfg. Company
DETROIT, MICHIGAN

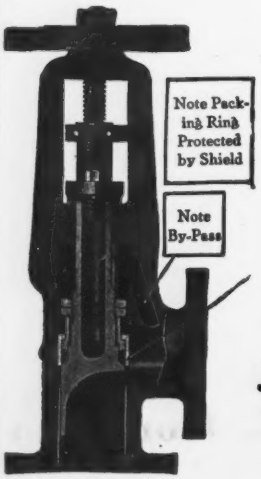
WESTERN BRANCH:
Scott Valve Company, 310 W. Randolph St., Chicago, Ill.

Absolutely TIGHT

Balanced—Seatless—Automatic

Schiller Blow-Off Valve

is always absolutely steam tight. Boiler pressure is on the shield, which expands the ring so it is tightened by its own boiler pressure. Packing rings protected by shield from flow of boiler while opening or closing. Circulation of water on opposite sides of valve gives perfect balance. Simple in construction, strong and durable in use, easily operated. **Guaranteed** at 350 lb. pressure with outlet open to atmosphere.



Schiller Valves are made in angle and straightway types, extra heavy iron body brass lined. Parts are **interchangeable.** Can be opened or closed in a few seconds.

Piston one piece of phosphor bronze and provided with stops so you can always see when valve is opened or closed.

Our descriptive catalog will be gladly mailed upon request.

Joseph F. Schiller
314-320 South Lawrence Street
PHILADELPHIA, PENN.
Direct Representation Wanted in Open Territory.

Prevent Fuel Waste

A leak past an improperly seating blow-off valve will waste a tremendous number of heat units that must be paid for by firing more coal.

Hundreds of dollars are lost annually by many plants from this cause—yet the remedy is simple and absolutely dependable.

Tight blow-offs are positively assured by the installation of

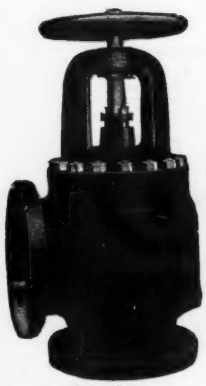
Hovalco-Homestead Double Blow-off Valves

They never stick, open to a positive point with straight away passage; time and labor savers.

It will pay you to install a few right now.

Homestead Valve Mfg. Co.
Homestead, Pa.

FOSTER ENGINEERING CO.
NEWARK, NEW JERSEY



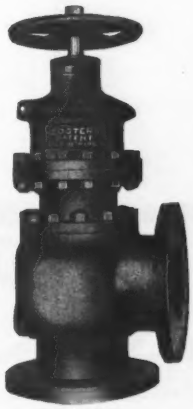
Regular: Angle and Globe Bodies

FOSTER

Automatic Non-Return Stop Valve
and
The Foster
Automatic Non-Return Emergency Stop Valve
(Four-Duty Valve)

For Saturated and Superheated Steam
Cast Steel and Semi-Steel Bodies

The Oldest, Most Reliable, Safest
Absolutely Dependable at all times
Does not Stick, Bind, Pound or Chatter
Thoroughly Cushioned



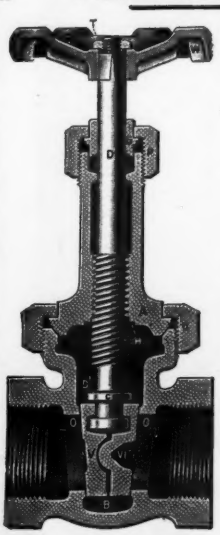
To Order: Side-Outlet, Cross or Elbow Bodies

Let us send you Bulletin No. 50—and tell you more about these valves, the functions of which are important factors of safety.

AGENCIES

Hiram Rivitz Co., Cleveland, Ohio
Walworth Mfg. Co., Boston, Chicago
Skinner & Seamans, Pittsburgh, Pa.
F. W. Hay & Co., Kansas City, Mo.
Power Plant Supply Co., Detroit, Mich.
Hanks-Price Co., Minneapolis, Minn.

POWELL VALVES
(Especially The White Star Valve)



The Powell
White Star Gate Valve

bonnet has a hexagon union swivel nut connecting with outside threads to the Valve body—where steam can't reach them. Notice the bevel ground joint contact. No chance for a blow-off—no red lead needed.

Observe the double discs with ball and socket back, smooth working and self-adjusting.

Ask your dealer for "POWELL" Valves or write us

THE WM. POWELL CO.
DEPENDABLE ENGINEERING SPECIALTIES.
CINCINNATI

Valve Service That Is Far More than Satisfactory

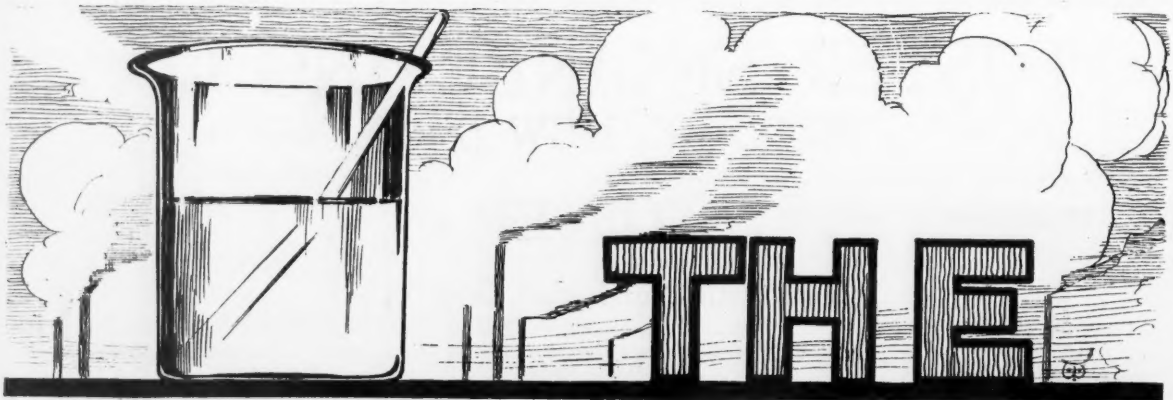
When 39 leading railroads of the United States accept a valve as standard equipment it indicates high merit. It is found in the

Everlasting Valve for Boiler Blow-off Service

Has a straight through blow. Self-cleaning and grinding seat. No stuffing box, no leaks, no repairing. Ample clearance space. Made in screwed and flanged ends, and also used as blow-down on drain or water columns. Guaranteed to give at least 2 years perfect service or money back.

Will send on free trial. Write for booklet.

Scully Steel & Iron Co.
2364 So. Ashland Ave.
P. O. Box 814 Chicago, Ill.



THE SOLUTION!

This being the Chemical Age, power plant men naturally turn to the chemist to solve their problems. They do well. Chemistry has done a lot for power plants. Take boilers as an illustration.

Chemistry discovered that scale, corrosion and pitting were caused by certain mineral salts in boiler feed. That they were in **all** waters, in some plentifully, in others slightly.

Dearborn Treatment

was evolved by Chemical Science to curb these evil elements in water. Our expert chemists first analyze the water, find out exactly what the noxious elements are, and then prepare treatment that neutralizes them. The treatment is varied as the water varies. No **guesswork** or **conjecture** when Science directs. Thousands of boilers now rely on **Dearborn Treatment. They're clean all the time.**

Our services are unrestricted. Send us a sample gallon of your boiler feed. We'll gladly analyze it and report details without obligation to you. Write for our booklet.

DEARBORN CHEMICAL COMPANY

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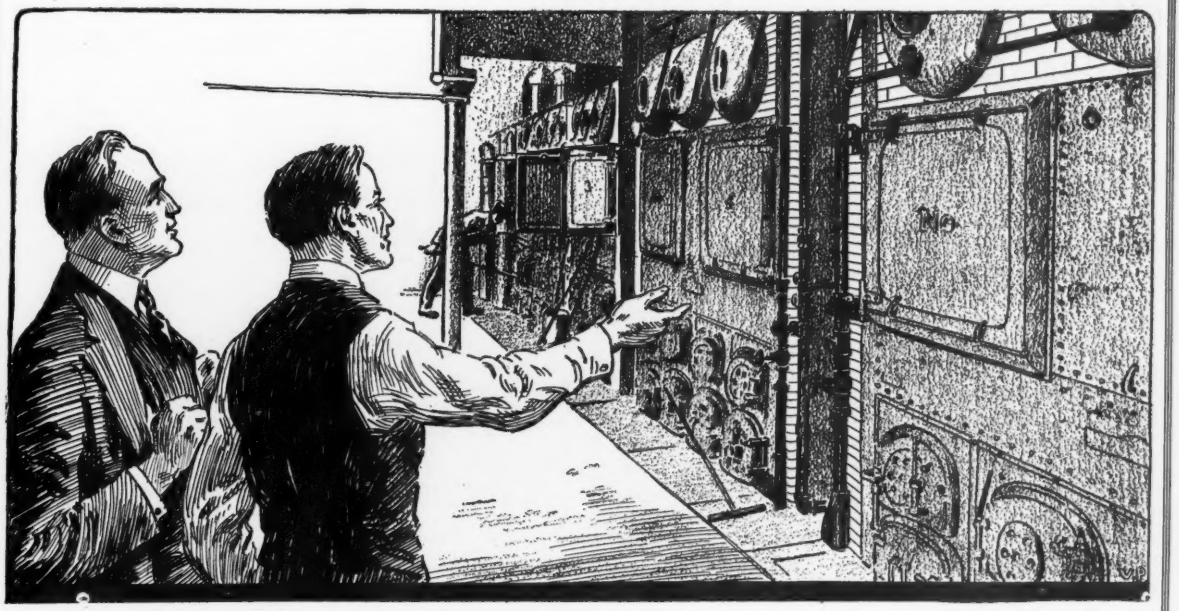
DEARBORN

INDIVIDUALIZED Water Treatment



You Cannot Prevent Boiler Scale But Dixon's Pioneer Boiler Graphite Simplifies its Removal

Nothing will more than partially prevent the formation of boiler scale when water contains solid impurities—even graphite will not do it. But—

DIXON'S PIONEER
BOILER GRAPHITE

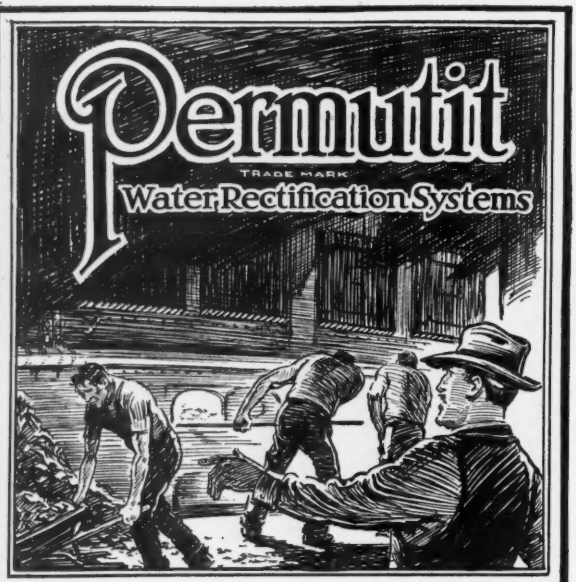
will help you to remove the scale with ease. That's the point we wish to impress upon your memory. You can clean—really clean—your boilers quickly and get them back in service. The saving in time and labor is fully 50%. Clean boilers steam better and burn less coal than boilers coated with stone.

Write for Bulletin 96-T

Made in JERSEY CITY, N. J., by the

Joseph Dixon Crucible Company

Established 1827



"Takes the H--- out of an Engineer's Life"

That's what the chief in one PERMUTIT equipped power plant told a PERMUTIT engineer. And he added:—

"There's no more drawing fires on Saturday nights, after the plant is shut down, to let the boilers cool—no more Sunday work in boilers still too hot for comfort.

"And, because our boilers are always clean now, we don't handle so much coal, by a big lot. It's easier to keep up steam.

"And when more steam is needed for overloads, it's easy to drive the boilers harder and meet the peaks.

"Another thing—the way we have reduced fuel and labor costs in here has put us all in right with the management."

Why don't you get in touch with a PERMUTIT engineer today? Write the nearest office.

The Permutit Company

Water Softeners *Filters*

440 Fourth Ave. **New York**

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79

Synonyms { Water Softening / Economy

$18,000.00 Yearly Tube Loss
15,000.00 Yearly Coal Loss
5,000.00 Yearly Labor Loss
$38,000.00

(Cost of Plant $30,000.00)

All saved by installing a

Vater Water Softener

Like savings can be made for you. Get busy. Write today.

Power Plant Specialty Co.

Monadnock Block, Chicago, Ill.

ASBESTOS

We are miners and shippers of Crude Asbestos in any quantity. We produce all grades at our world-famous BELL ASBESTOS MINES in Canada. We also card fibers, spin yarns, weave cloths and make all sorts of Asbestos products.

For anything you want in Asbestos, turn to

Keasbey & Mattison Company

Ambler, Penna., U. S. A.

Dept. S-7

Owners of the World's Largest Asbestos Mines

GENUINE

Armstrong Stocks and Dies

For Threading Pipe or Rod

Pipe Cutters

Malleable Iron Hinged Pipe Vises

Manufactured by

The Armstrong Manufacturing Company

320 Knowlton Street, Bridgeport, Conn.

Makes Every Drop of Oil Do Its Duty

SEE OUR CATALOGUE IN SWEET'S

Fifth Annual Edition Page 504

ROCHESTER

CLUTCH DRIVE AUTOMATIC LUBRICATOR

Less noise than a watch—as positive in performance as the passage of time—as enduring as the engine of which it becomes a part—so saving that it adds to the user's profit by minimizing oil consumption every minute it is in use. The foregoing are a few of the advantages of the ROCHESTER.

IMPROVEMENTS:

Positive Clutch Drive—Positive, easily regulated and absolutely noiseless. Just the thing for high speed engines.

Tight Stuffing Box—Made stronger and larger, thereby permitting the use of more Palmetto Packing, guaranteeing tight stuffing boxes and smooth running pistons.

Automatic Gauge Glass Fixture—Prevents oil from running out over the floor if gauge glass breaks. Valve in lower fixture automatically shuts off the oil and the lubricator keeps on just as though nothing had happened.

All Working Parts Encased—Protected from dirt, grit, etc., yet always get-at-able.
Appearance—Unsurpassed—an ornament to engine, pump or compressor.

COSTS YOU NOTHING TO TRY IT

We know that the ROCHESTER will save you from 25% to 60% of your usual oil expense because more than 20,000 users have been getting such savings. And to prove it to you, we will gladly send you a ROCHESTER CLUTCH DRIVE AUTOMATIC LUBRICATOR for 30 days' free trial in your own plant. Besides, if you decide to keep it, we'll make you an allowance on your old lubricator. Act now for your own sake.

Greene, Tweed & Co., 109 Duane St., New York

English Agents—Jenkins Bros., 6 Great Queen Street, Kingsway London, E. C. England.

TRIED and PROVEN

Over 30 years of real service has proven the Cyclone Lubricators.

They are made in a variety of sizes and connections and are stocked by all leading jobbers.

Printed matter on request

MICHIGAN LUBRICATOR COMPANY

Detroit, Mich., U. S. A.

Prevents Unnecessary Waste

Oil is just as expensive as everything else right now, and its conservation should be practiced as rigidly as that of any other necessary commodity.

It is criminal to allow oil that has been used only once to go to waste down the sewers or drains. It could be used over and over again by installing in your plant a

SIMS OIL FILTER

which would wash all the impure matter from the oil and make it clean and fit for use again. This can be done several times over, reducing your oil bills fully 65%.

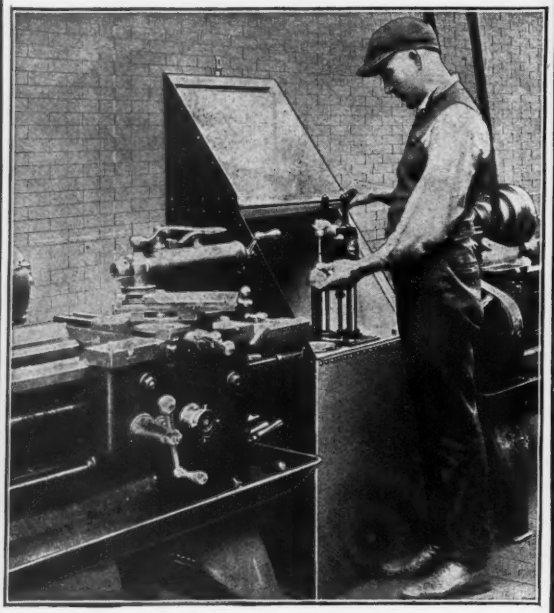
30-days Free Trial

The Sims is simple in construction and economically operated. Write for bulletin and trial offer.

THE SIMS COMPANY

2001 Holland Street Erie, Penn.

Prevent Idle Time
of Men and Machines



By placing Bowser Lubricating Oil Cabinets in departments where oil is used.

There is no going back and forth to the oil room, no spilling, no wasted oil, no fire risk from the oil storage.

Save the Oil

The oil supply can be stored and handled as systematically as raw materials or finished parts—income checked, distribution measured, charged and recorded.

Write for literature, explaining why and how Bowser Systems pay for themselves, many times over in saving of oils and labor.

S. F. BOWSER & CO., Inc.
FORT WAYNE, IND., U. S. A.
Branch Offices in 21 Cities of the United States
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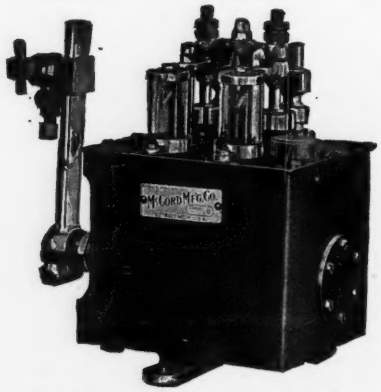


"McCord" Class "B" Force Feed Lubricator—2 Quarts—2 Feeds

As Runs the Engine So Runs the Factory

To insure continuous and reliable production service from the factory it is imperative that the power plant be operated efficiently.

And positive, dependable lubrication is a most important factor in the operation of the power plant.

The design and construction of the McCord Force Feed Lubricator makes economic, right oiling a certainty. It has been adopted as standard equipment by many leading manufacturers of steam, gas and oil engines, air and ammonia compressors, Diesel engines, etc., because of its superior operating features.

Comparison proves the McCord to be the simplest lubricator in design, construction and operation. It is built up in units. Each pump is complete in itself and may be removed for inspection or operation independent of the other pumps.

Pump units are made of cast bronze and will not corrode.

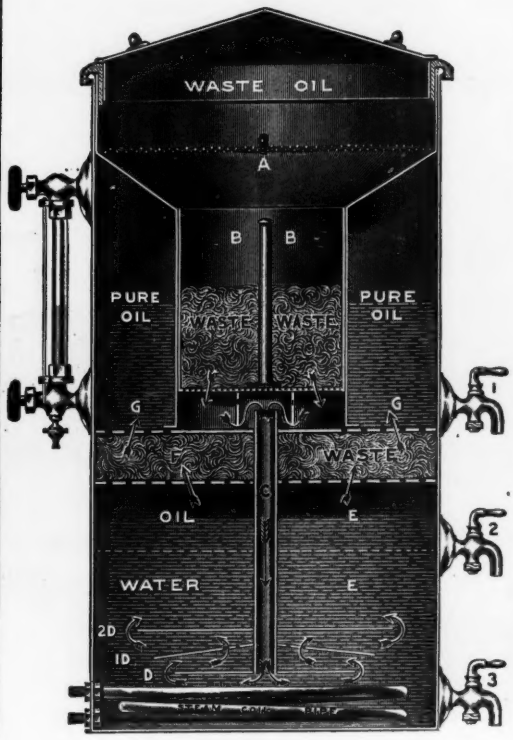
Driving mechanism is of forgings, case hardened in oil. This insures great durability.

The complete facts about the McCord Lubricator and the service it delivers in the hands of users will be sent gladly. Write for catalog.

McCord Manufacturing Company, Inc.
Detroit, Mich., U. S. A.
Also Manufacturers of the McKim Copper Asbestos Gasket

McCORD FORCE FEED LUBRICATORS

Give Economy a Chance



Free Trial Offer

We will send to any responsible house one or more of our Oil Filters on 30 days' trial. If they do not reduce lubricating bills at least 50 per cent, they may be returned and we will pay freight charges both ways.

The **BURT Catalog,** 128 pages, a veritable encyclopedia on the subject of lubricating oils, will be sent FREE to any power plant man interested in profitable oil saving. Write us—now—that means TODAY.

We also carry a complete line of Ventilators and Exhaust Heads as well as Oil Filters and are in a position as to make immediate shipment.

You want the highest possible economy in your plant—we know that. That is why you **are** the boss.

Of course, you must adhere to strict economy in **every department** and in **every particular.** If you keep "close tab" on the quantities of coal you burn, in order to save fuel, and at the same time neglect to give more than a passing thought to the amount of oil your plant consumes—why then you're not practicing strict economy. **You are going against it.**

BURT Oil Filters

know how to save oil and make your plant more efficient. Install a **Burt,** and you can then have the pleasure of watching the high cost of lubrication dwindle down to a mere shadow of its former size.

When oil has, through usage, become dirty, **don't throw it away,** but let the **Burt Oil Filter** wash it of all its dirt and impurities; **and then use it again.** You can do so many times, or as long as the oil lasts.

The **Burt's** business is to cut down oil bills 50 to 90 per cent.

Here is true economy.

The United States does not disdain to **economize** by saving oil. It has officially adopted **Burt Oil Filters** for that purpose and they are making money for UNCLE SAM. **Twelve other great Governments** have followed the example set by UNCLE SAM. Even the greatest oil producer in the world, the Standard Oil Company, finds **Burt Oil Filters** pay, and uses them.

Once installed there is practically no operating expense to the **BURT,** while the first cost is so slight compared with the savings effected as to be negligible.

BURT Oil Filters are made by the largest manufacturers of oil filters in the world. They are sold to and satisfy the users in 29 foreign lands.

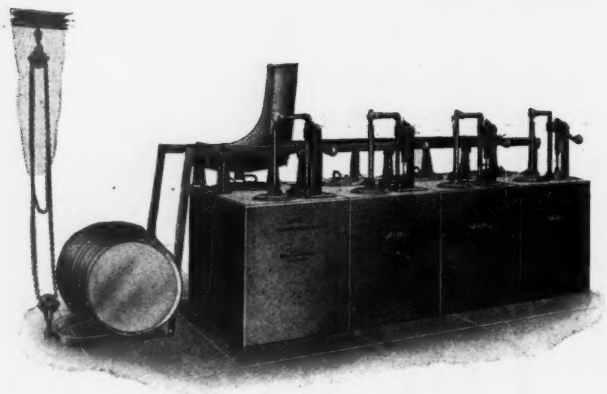
Your plant—any plant—can benefit by this wonderful filter. Why don't you—NOW?

The Burt Manufacturing Company

44 E. South Street, Akron, Ohio, U. S. A.

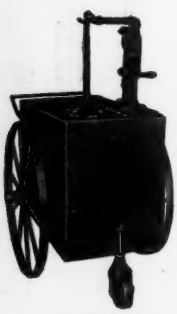
Largest Manufacturers of Oil Filters in the World

Wayne



Cut 65 Battery for Oils

Cut 65 for Oils



Cut 224 Portable

Service To

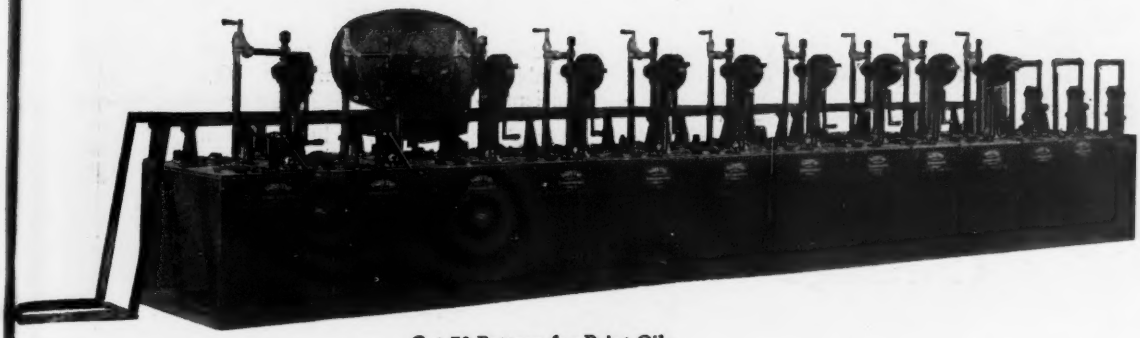
Thousands of buildings representing practically every kind of industry—from the largest paint manufacturers using dozens of grades of oils, to the private garage of the humblest home that sports a car—using Wayne Systems, proving Wayne Service is Unlimited.

In plants that successfully create and distribute power you will find Wayne Oil and Liquid Storage Systems saving oil, time, labor and trouble, protecting mammoth bearings from the ruin of wrong lubricants and saving the plant from the fire hazard of oil soaked floors.

The distance of storage from distribution, working conditions, complication of factory layout, climate, limitations of space or chemical analysis of the liquid—none of these present problems that cannot be worked out the Wayne Better Way.

Wayne Oil and Liquid Storage Systems pay for themselves in the oil they save. Leak-proof, fire-proof, dirt and dust proof, exact in measure, quick in

Unlimited



Cut 70 Battery for Paint Oils

To Industry

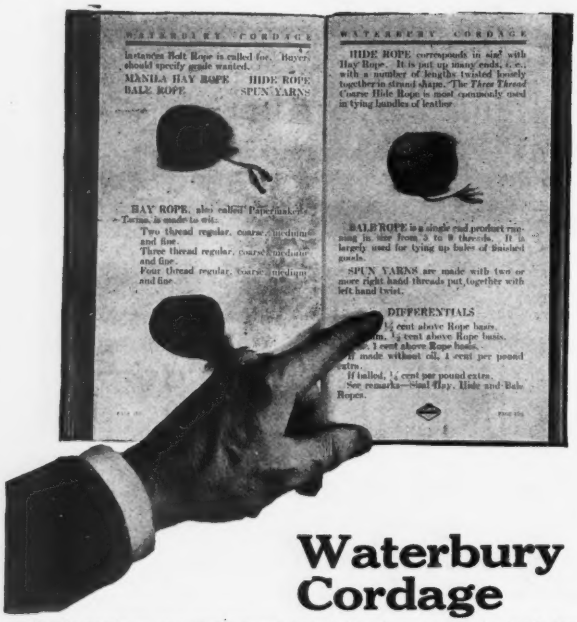
action and lockable against theft and tampering—no plant or industry can afford to be without them.

A corps of oil and liquid storage engineers together with a vast fund of practical knowledge is at your disposal free of any obligation. When you write ask for Bulletins 65-35-224 and 70 PPE.

Oil and Liquid Storage Systems, Oil Burning Systems, Metal Forging, Heat Treating and Metal Melting Furnaces and Oil Filtration Systems.

Our factory is working overtime to meet the demand for Wayne Systems. We must maintain Wayne Quality for Wayne Quality created the demand.

WAYNE OIL TANK & PUMP CO.
574 CANAL STREET FT. WAYNE, INDIANA


WATERBURY CORDAGE
instances Belt Rope is called for. Buyers should specify grade wanted.
MANILA HAY ROPE HIDE ROPE
BALE ROPE SPUN YARNS
HAY ROPE, also called Papermakers' Twine, is made to suit:
Two thread regular, coarse, medium and fine.
Three thread regular, coarse, medium and fine.
Four thread regular, coarse, medium and fine.
WATERBURY CORDAGE
HIDE ROPE corresponds in size with Hay Rope. It is put up many ends, i. e., with a number of lengths twisted loosely together in strand shape. The Three Thread Coarse Hide Rope is most commonly used in tying bundles of leather.
BALE ROPE is a single end product running in size from 3 to 9 threads. It is largely used for tying up bales of finished goods.
SPUN YARNS are made with two or more right hand threads put together with left hand twist.
DIFFERENTIALS
cent above Rope basis.
cent above Rope basis.
1 cent above Rope basis.
made without oil, 1 cent per pound extra.
If tailed, ¼ cent per pound extra.
See remarks—Sisal Hay, Hide and Bale Ropes.

Waterbury Cordage

If it's cordage, the Waterbury brand is all you have to look for. The Waterbury Company has made that brand mean standard quality for more than a hundred years on every sort of cordage, from twine to 15-inch hawsers.

And the rope "dope" that a century of experience accumulates is yours for ready reference in the Waterbury Rope Handbook. Ask for a copy. It's free.

WATERBURY COMPANY

63 PARK ROW, NEW YORK

Chicago San Francisco Dallas, Texas New Orleans

2352-W

The More Severe the Duty The More the Need of "Morse"

Before buying belts, gears, rope, investigate the drive that is making history by increasing production, keeping down maintenance and lowering depreciation.

If your drive is now giving you trouble, or you need one for service in Dust, Gases, Acid Fumes or Steam; or if you require more speed or an increase in power, install the perfect, durable, positive transmission—99% efficient.

Morse Engineers will help you on any drive problem.

WRITE

MORSE CHAIN COMPANY

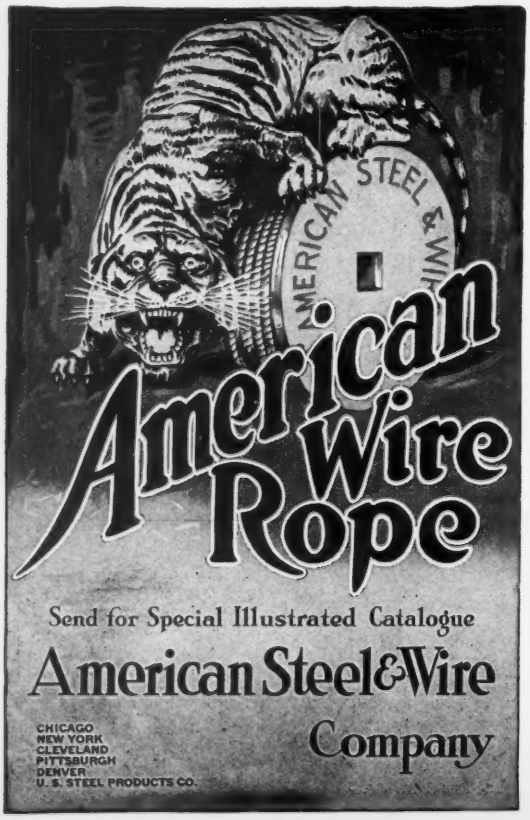
MORSE CHAIN COMPANY ITHACA, NEW YORK

Largest Manufacturers of Silent Chains in the World.

Cleveland	Greensboro, N. C.	San Francisco
Chicago	Detroit	Montreal
Boston	Pittsburgh	Minneapolis
New York	Atlanta	St. Louis

ITHACA, N. Y.

"Morse" is the guarantee always behind the Efficiency, Durability and Service.



GOODRICH Rubber Transmission Belting has greater gripping power, less stretch than leather or canvas and is extremely flexible.

Send for Catalogue

THE B.F. GOODRICH RUBBER CO.
The City of Goodrich—AKRON, OHIO

GOODRICH
TRANSMISSION BELTS

WRITE FOR CATALOGUE No. 10

TANNERS AND LEATHER BELT MANUFACTURERS

Chas. A. Schieren Company

ESTD 1868

31 FERRY STREET
NEW YORK, N. Y.
U. S. A.

BRANCHES OR AGENTS IN ALL IMPORTANT CITIES

"Now what do you think of that? Isn't that one dandy Christmas present? What did the boss say when he promoted you, George? How much more pay is in it? When do you take charge? What"—

"One at a time, honey! Take your time! Don't get excited."

"Oh, dear, I'm **so** tickled! I was only saying to George Stephenson Watts here today, 'Your daddy's a great man and they can't keep him down.' And the little lamb answered, 'I'll say he is.' Wasn't that **too** cute?"

"He's the original infant phenomenon! And now for your questions. First the boss says:

"'George, you'll go on the payroll as Chief Engineer in charge of all our plants, effective January 1, at $25 more per week. I have been especially pleased at the better belt service we have been getting, with its attendant economies, ever since we began using

Cling-Surface

"'I don't mind saying now that I was angry when you got **Cling-Surface** without my permission. Since then I have been observing the difference it has made on our belts, **and I'm more than pleased.** It also made me think that a young man as solicitous as you were for his employer's interest was worth encouraging.

"'**Cling-Surface** has saved us considerable money in these few months, especially with the price of belting where it is now. We haven't had to buy any new belting; our old belts are in better condition than they ever were before; there has been no extra work or pay for **tightening** up; no interruption of production and less coal burned under boilers.

"'**Cling-Surface** has saved us some hundreds of dollars already. One of your new duties will be to see that slack belts are run in all our plants, and that **Cling-Surface** is standardized **in each one.**'

"That's all. Go ahead with your questions."

Your plant can benefit from Cling-Surface also. It comes in 25 and 50-lb cans, and we'll send you a can on approval, pay if O. K. The 50-lb. is a little cheaper than the 25-lb. Just write us.

CLING-SURFACE COMPANY, 1028 Niagara Street BUFFALO, N. Y.

MAIL THIS COUPON

CLING-SURFACE CO., 1028 Niagara St., Buffalo, N. Y.
Gentlemen: Please send me items herewith checked:

☐ Cling-Surface booklet 5. ☐ 25-lb. can Cling-Surface. ☐ 50-lb. can Cling-Surface. ☐ Place my name on your mailing list.

Name.....

Address ..... P.P.E. 12-15-19

No More Or No Less!

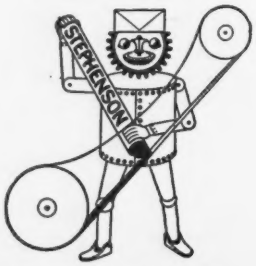
A manufacturer wrote us the other day and said:

"Your Belt Dressing does just what you claim—NO MORE OR NO LESS. We are very much pleased with it."

We consider this a splendid testimonial, for our claims are simply: It stops slippage and keeps belting soft and pliable, with entire satisfaction to the user.

May we demonstrate with a large sample bar? Yours for the asking.

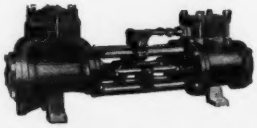
"IT-MUST BE GOOD"



The Man with the Cog-Wheel Face on each bar.

Stephenson Mfg. Co.

Albany, N. Y., U. S. A.



The Valve Movement

of DEAN BROS. DURABLE DUPLEX STEAM PUMP is the most important improvement that has beeen made on a duplex steam pump for twenty-five years. Send for Catalogue 106.

DEAN BROS. STEAM PUMP WORKS. INDIANAPOLIS.

NOT IN THE PUMP TRUST.

10 to 15 per cent Saving in Coal
28-inch Vacuum the Year Around

The Center Jet Does It
With a Finely Atomized Spray

The Boiler Metal Treatment

The Modern Method of Boiler Scale Removal and Prevention

Removes Scale by Mechanical Expansion

See me "Expand" in next issue

Perolin Co. of America

New York Chicago
St. Louis Toledo

For Quick Action Opportunities Read the Signboard Section, Pages 100---101---102---103

Surface Barometric and Jet Condensing Equipments for Power Plants.
Main, Auxiliary, Distilling Condensers & Evaporators for Marine Service.
Distilling Condensers for Refrigeration and Chemical Plants.

"Crosshead Guided" Expansion Joints.
Ross Boiler Feed Water Heaters.
Ross Oil and Sugar Juice Heaters.
Gravity & Forced Circulation Heaters.
Ross Oil, Air and Water Coolers.

ROSS HEATER & MFG. CO., Buffalo, N. Y.

THE BRAND THAT LEADING ENGINEERS DEMAND

Condensing Apparatus

We specialize in the Design and Construction of

Surface Condensers
Jet and Barometric Condensers
Air Pumps
Centrifugal Pumps
Water Cooling Towers
Expansion Joints
Atmospheric Relief Valves
Low Pressure Exhaust Gate Valves

Let us assist you in solving your condensing problems.

C. H. WHEELER MANUFACTURING CO.

Philadelphia, Pa.

BRANCHES

New York, Boston, Chicago, Pittsburgh, Charlotte, New Orleans, San Francisco, Seattle.

The GIANT of SERVICE

Within the compact casing of each **RoTURBo** there is an unseen giant of efficient service.

Its spirit is the new hydraulic principle, whereby power is freed from the indirect method of creating speed energy and is applied to the development of pressure head directly, without the loss incident to converting speed energy back to pressure head.

Its body shows the clean-limbed, sturdy simplicity of its design, which leaves no place for undue wear and no weak points.

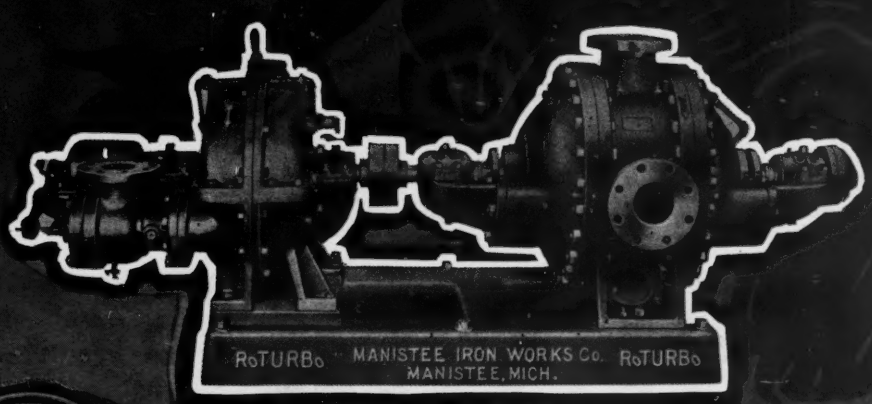
Its bone and sinew are the most perfect metal mixtures, machined true and passing the most exacting inspections.

RoTURBo has permanent and high efficiency over a wide range as an inherent characteristic—flat power and efficiency curves with varying discharge at constant speed.

Complete information promptly on request.

Manistee Iron Works
Manistee, Mich.

RoTURBo PUMPS



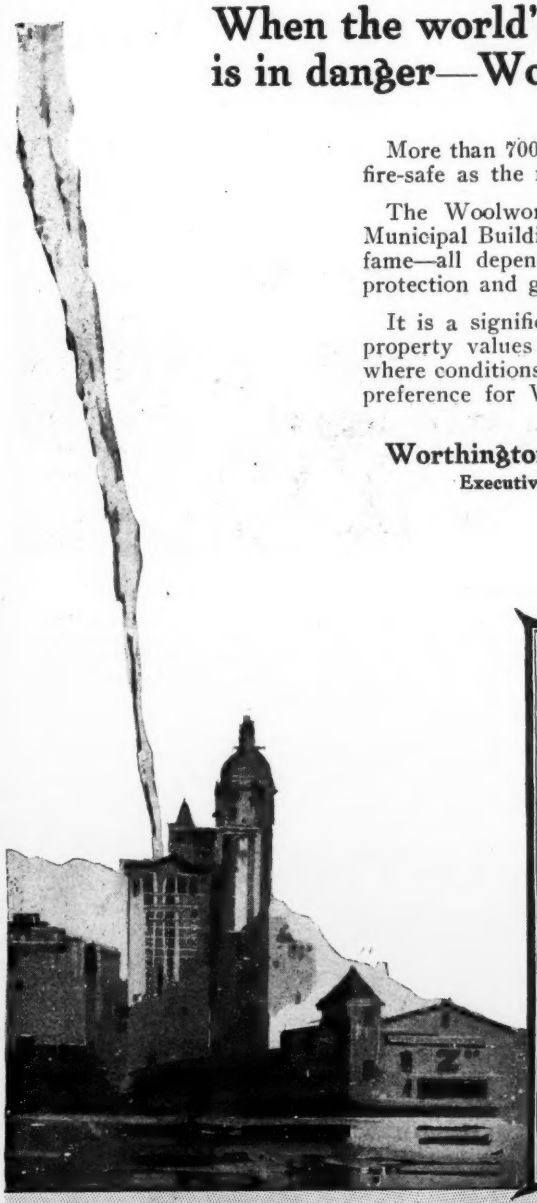
"RoTURBo" CENTRIFUGAL PUMPS - AIR PUMPS
MADE BY MANISTEE
ROTARY JET CONDENSERS

PUMPS–COMPRESSORS–CONDENSERS–OIL & GAS ENGINES–

WORTHINGTON

Worthington Works
Harrison, N. J.
Blake & Knowles Works
East Cambridge, Mass.
Deane Works
Holyoke, Mass.
Hazleton Works
Hazleton, Pa.

When the world's highest building is in danger—Worthington Pumps protect it



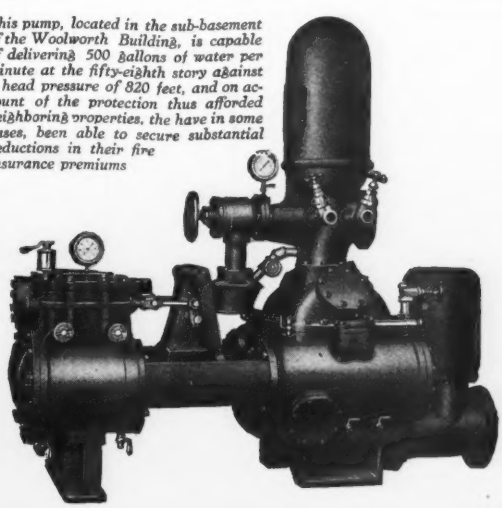
More than 700 feet above the street, yet the 58th floor is as fire-safe as the first.

The Woolworth Building, the Metropolitan Tower, the Municipal Building—engineering achievements of world-wide fame—all depend on Worthington equipment for both fire protection and general service.

It is a significant fact that throughout New York, where property values demand the most infallible protection, and where conditions of service are most severe, there is a decided preference for Worthington equipment.

Worthington Pump and Machinery Corporation
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

This pump, located in the sub-basement of the Woolworth Building, is capable of delivering 500 gallons of water per minute at the fifty-eighth story against a head pressure of 820 feet, and on account of the protection thus afforded neighboring properties, the have in some cases, been able to secure substantial reductions in their fire insurance premiums

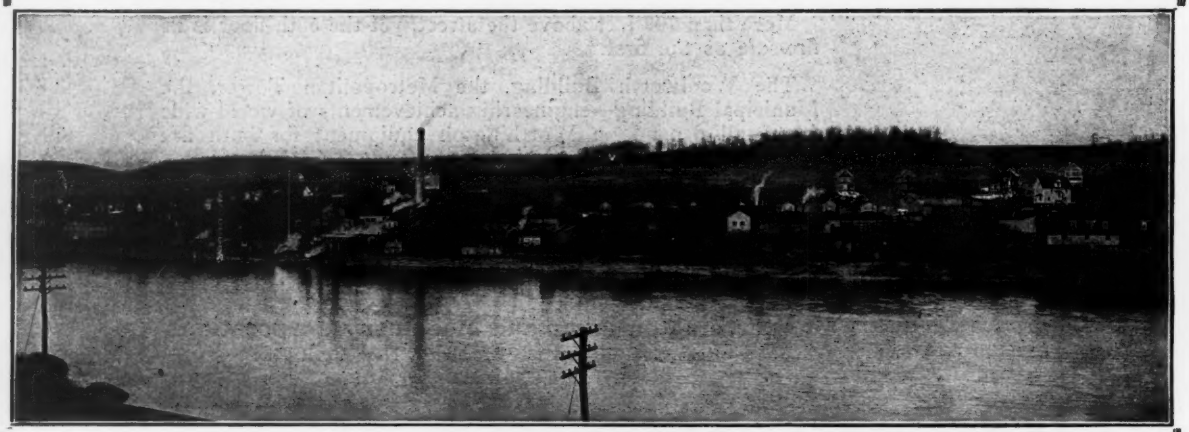


-METERS-MINING-ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

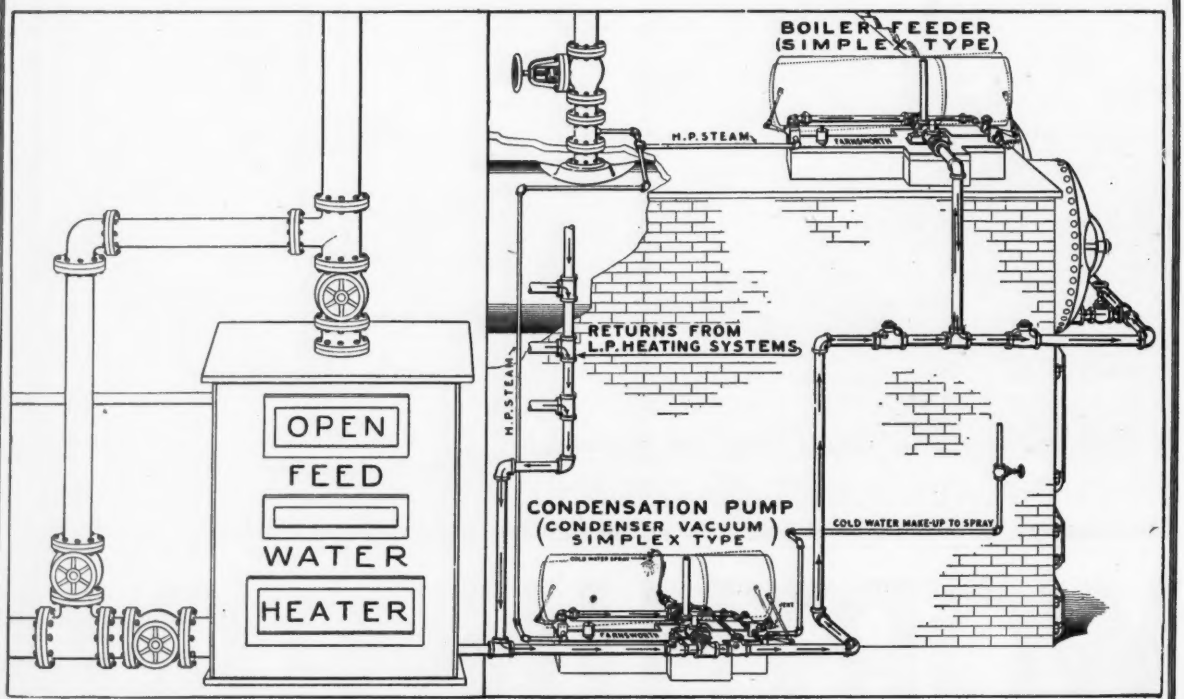
Snow-Holly Works
Buffalo, N. Y.
Laidlaw Works
Cincinnati, Ohio
Power & Mining Works
Cudahy, Wis.
Gas Engine Works
Cudahy, Wis.

Farnsworth Saving 1000 Tons Coal Per Day In U. S. Mills



The Farnsworth Guarantee

Farnsworth Systems are now saving more than 10% of coal in 500 plants. The Empire Oil Works, Oil City, Pa., contributed to this remarkable record when they shut down one of five 200 H. P. boilers as soon as our machines were connected. A panorama of the Empire plant is shown above. We have shut down more than 100 large boilers that were not required after our system was started, and our Closed System is now saving at least 1000 tons of coal per day in the United States.



How Farnsworth Saves Coal

By closing up the system and feeding the water into boilers under pressure at a temperature of 300 degrees or over, thereby conserving the heat units in the high temperature condensate from heating systems, heated apparatus, etc.

FARNSWORTH COMPANY *Engineers and Manufacturers of Condensation Pumps* **Conshohocken, Penna.**

CANADIAN FAIRBANKS-MORSE CO., Limited, Manufacturers and Distributors for Canada.
FAIRBANKS-MORSE & CO., Inc., Agents and Distributors Pacific Coast.
FAIRBANKS-MORSE CO., LONDON, ENG., DISTRIBUTORS.

AMERICAN
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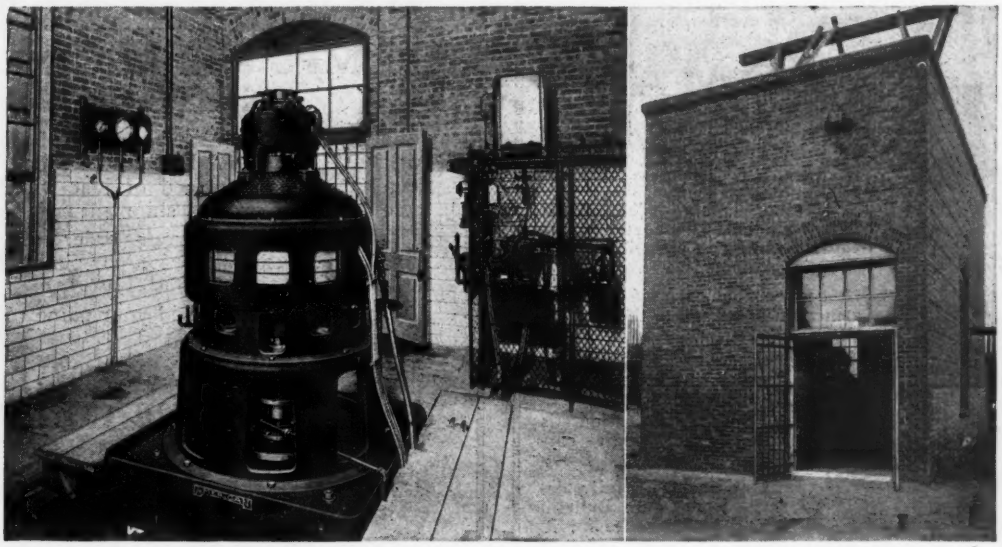


Saving Over Half the Cost of Pumping Paying for the Installation in Less Than a Year

We installed for the Cudahy Packing Co., at their South Omaha plant, a combination deep well turbine and booster centrifugal pump.

The installation consists of a five-stage turbine located 200 feet below the surface and a two-stage booster mounted on the same shaft at the surface, and is designed to pump 2,000 G.P.M. and elevate it 162 feet above the surface, or discharge against 70-lb. pressure.

The pump alternately raises water from 165 feet below the surface and discharges against 80-lb. pressure.

This pump is driven by a vertical type 300 kv.a., 3-phase, 60-cycle, 550-volt, synchronous motor operated at 900 r.p.m.

This pump is installed in a well only 18⅞ inches in diameter inside of casing.

The above illustrations show exterior and interior views of this installation.

The guaranteed combined efficiency of these two pumps operating in series was 63 per cent. By actual test, the pump is maintaining a combined efficiency of about 73 per cent.

This unit is in practically 24-hours-per-day, seven-days-per-week service, it being shut down only for inspection.

A careful record of the costs of operating this installation shows that it pumps water at about 1.8 cents per thousand gallons for power, or about 3.5 cents per thousand gallons including all fixed charges such as interest, depreciation, repair, labor, oil supplies and power.

Before this installation was made the company had been paying 8 cents per thousand gallons for water, or more than double the present cost. This saving in cost of pumping will pay for the entire installation in considerably less than one year.

This is only an example of the economy we are obtaining with these combination pumps in numerous deep well water supply installations.

Catalog 149 describes these pumps
Mailed free for the asking

The American Well Works

General Office and Works: Aurora, Ill.
Chicago Office: First National Bank Bldg.

A BIG PROBLEM

is that of sewage removal from sub-basements that are below the sewer level. However, those who are equipped with

YEOMANS
Electric Bilge Pump

never worry. They know that their basements will be kept dry.

The pump is suspended in the catch from the basin cover, and is operated by an electric motor which is connected to it.

A copper float suspended in the basin rises or falls with the level of the water. Above or below a certain level it starts or stops the motor. No attention required.

Perfect lubrication is assured and shaft corrosion prevented.

Our device is fully described in our Bulletin No. B-3000. Write for it.

Yeomans Bros. Company
1432 Dayton St.
CHICAGO
Agents in Principal Cities

TRANSIT

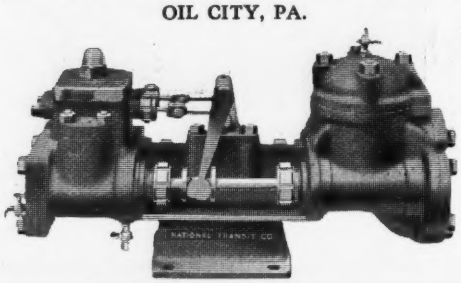
PUMPS and ENGINES IN STOCK

Each month we issue a 16-page booklet, entitled "Pumps and Engines In Stock," to keep the trade informed of just what we have ready for prompt shipment.

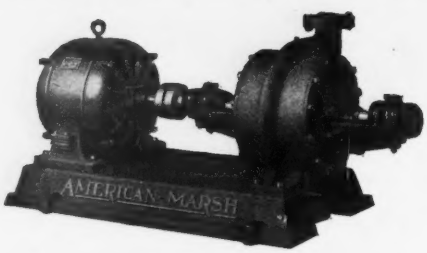
Before you place your order for six months' delivery write for our Stock Bulletin.

We will be glad to add your name to our mailing list.

NATIONAL TRANSIT PUMP & MACHINE COMPANY
OIL CITY, PA.



Efficiency

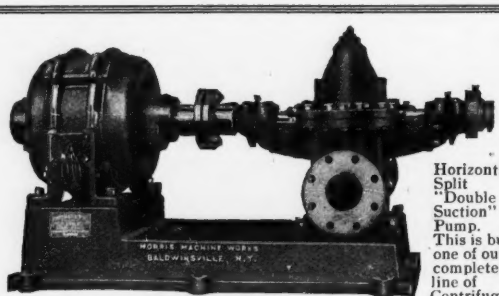


American-Marsh Centrifugal Pumps

are equipped with extra wide ring oiled bearings. Removable outer head so that impeller may be withdrawn without disturbing the casing. Hydraulically balanced impeller, insuring minimum end thrust. Impeller machined all over and turned to make a close running fit with the casing.

Investigate. Ask for Bulletin No. 33
Furnished promptly upon request.

American Steam Pump Company
Battle Creek, Mich.
Manufacturers of Steam and Power Pumps and Air Compressors



Horizontal Split "Double Suction" Pump. This is but one of our complete line of Centrifugal Pumps.

Have you our power plant pump catalog?

MORRIS MACHINE WORKS
Builders of Dredges, Centrifugal Pumps and Steam Engines
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TABER PUMPS

Highly Efficient, Low Cost Units for All Pumping Services from 5 to 100 ft. Head and from 30 to 1200 G. P. M.

"V" Type Volute Belt Driven Centrifugal Pump

Built for enduring service without care or repairs, Taber Centrifugal Pumps are demonstrating their efficiency and economy in hundreds of plants. Steady flow, no packing and valve troubles; belt or motor drive; ready to ship. Write for circular and engineering recommendations for your special pumping problems.

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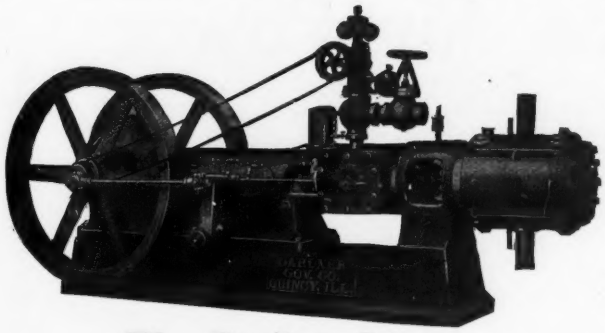
Why Do You Get the Most From Gardner Air Compressors?



When you are considering the purchase of an air compressor the one big thought is the machine which can be operated at the minimum expense and up-keep and give you adequate air pressure at all times.

Choose a machine which blends good material, workmanship, honest manufacture, designed for strength, simplicity and accessibility.

You will then get the machine best suited for your needs.

All these features are found in a Gardner compressor.

Result of fifty years manufacturing experience. Made in a variety of sizes and types to meet every need. Let us advise you regarding your air compressor wants.

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Duplex Power Pumps **Duplex Steam Pumps**
Air Compressors **Engine Governors**
Steam and Oil Separators

The Gardner Governor Company

Power Plant Department **18 Williamson Street** **Quincy, Illinois**

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ELESCO SUPERHEATERS

Save Fuel.
Reduce condensation.
Increase boiler capacity.
Pay for themselves.

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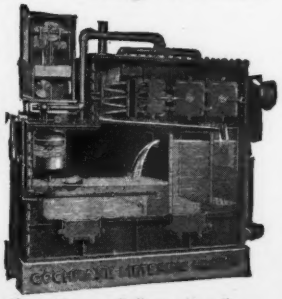
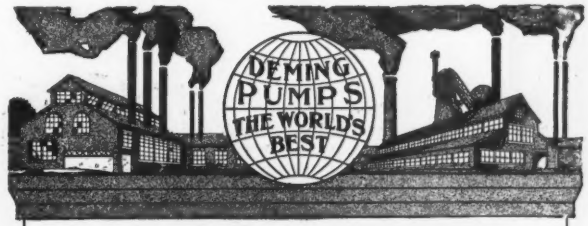
The Cochrane Metering Heater

is a combination of the well-known Cochrane Open Feed Water Heater and the V-Notch Weir Meter. The V-notch meter is exceedingly well adapted for power plant purposes, since it has a good accuracy at small flows as well as at full capacity, also because it is exceedingly simple and easily inspected, and because the Cochrane Recorder which we supply therewith is a durable, reliable device that does not get out of order.



Every man who has a boiler plant under his charge should read our publication, "Boiler Room Wastes, Their Detection and Correction."

Harrison Safety Boiler Works, 3144 North 17th St., Philadelphia, Pa.



Deming Power Pumps

are serving in hundreds of plants for Boiler Feeding, Fire Protection, Hydraulic Elevator Service, Oil and Chemical Pumping or General Water Supply.
Their records are such that we can name as references the users of Deming Pumps nearest you.

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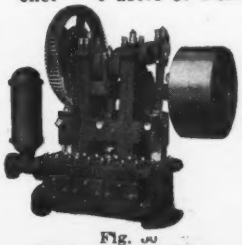

Fig. 90
Triplex Power Pump.
Size 5½x8.
With Tight and Loose Pulleys.

The Deming Company
Salem, O.

Henlon & Hubbell, Chicago.
Ralph B. Carter Co., New York.
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Inexpensive Air Power

Install an Ingersoll-Rand Small Compressor and a **low cost air service** is yours. You take no chance, for, "when you chose I-R, the risk in buying is past."

I-R Class "ER" (Belted) and Class "FR" (Steam Driven) Compressors are of a perfected design and built to exacting standards in the quality of materials and of precision in workmanship—the outgrowth of years of specialization on pneumatic machinery.

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The belted Class "ER" can be had with or without electric driving motor and short belt drive attachment—the steam driven Class "FR," with its piston steam valve, for operation under any steam conditions, high pressure and superheat as well as lower pressures.

We will be glad to present a detailed discussion of features of design and construction.

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28-955 cu. ft. capacity.

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67-1086 cu. ft. capacity.

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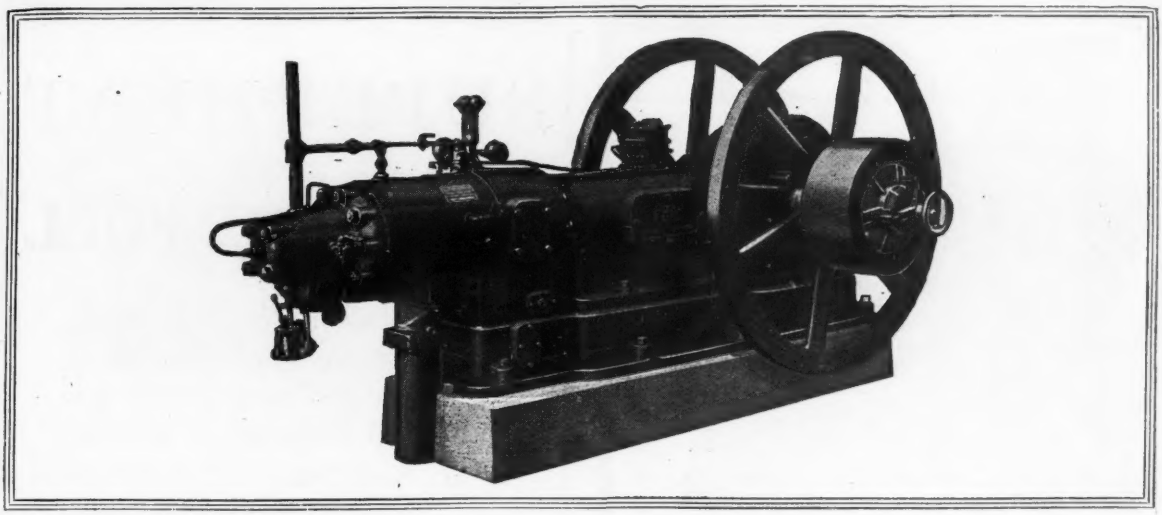

"Built like a high grade steam engine" in capacities from 20 to 160 H.P., in both single and duplex types, Giant Semi-Diesel Oil Engines embody such feature as box type cross-head construction, hot-liner ignition, and automatic regulation. Engine units for general power purposes, or complete electric generating or pumping plants, can be supplied to meet any service conditions. Performance records of "Giant" dependability and economy under all service conditions, are available to aid in determining their value to you. Write for bulleti

Oil, the fuel for dependable power, costs less, is plentiful and readily procurable, and permits the design of engines so sturdy and simple in construction that their operation requires practically no attention beyond the supplying of fuel and lubricant.

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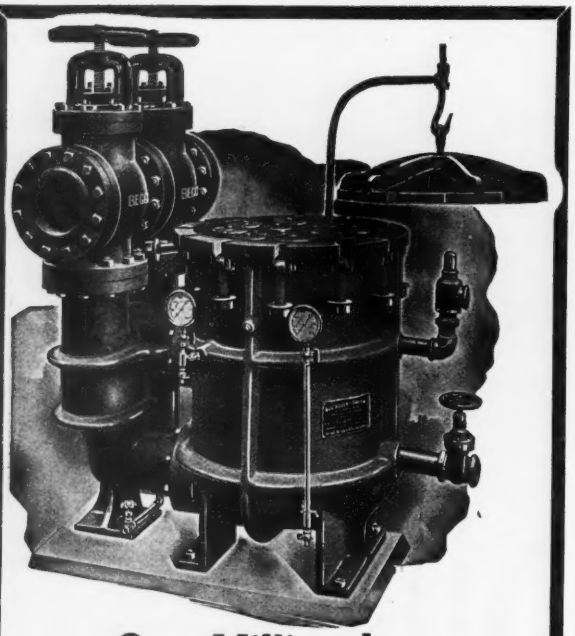

One Million h. p.

of boilers now protected by the

BLACKBURN-SMITH Feed Water Filter and Grease Extractor

Where They Are:

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Why the Filters went in:

Installation of the filter on the feed line just before the water enters the boilers assures thorough cleaning **of all water** passing to the boilers.

The **separated** and uniform terry cloth surfaces give **two successive** filtrations.

The small filtering cartridges are so easily handled as to permit quick removal of foul filter stockings and their replacement by clean ones, without stretching or injuring the terry cloth.

The filtering efficiency does not decrease by use and the up-keep expense is practically nothing.

Our advice, based on experience gained in the ten years during which this filter has been manufactured by us, is at the command of interested parties.

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"FEED WATER FILTRATION"

The BLACKBURN-SMITH CORPORATION

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Agents in all Principal Cities of the United States and Canada

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SUPERHEAT AND CONSERVE FUEL

It is not a theory but a condition that confronts all makers of power and they should get posted at once on a reliable way of saving coal—write to us, we can give you some information.

DRAVO COMPANY

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SUPERHEATER AND ENGINEERING CO.
1812-14 Woolworth Building, New York City
Licensed Builders for Eastern Atlantic States

Merry Christmas

and

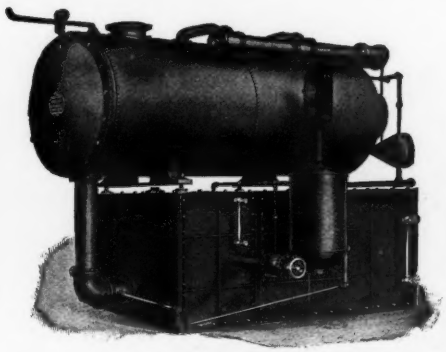
A Happy New Year

1919-1920

At Christmas play and make good cheer for Christmas comes but once a year

THE PATTERSON-KELLEY CO. NEW YORK
WATER HEATING ENGINEERS

24 Cortlandt St.



An Ideal Combination for Maximum Efficiency

It is the Hoppes Feed Water Heater connected up to the Hoppes V-Notch Meter, and it is wonderfully effective in reducing operating expense.

After the water has been heated and purified, it passes on to the storage tank below, where it is metered. A record of the rate of flow is made on a circular chart, and the integrator on the opposite side of the head indicates and records the amount of water passed.

HOPPES

Exhaust Heads, Steam and Oil Separators, Live Steam Purifiers, Feed-Water Heaters, Etc.

This apparatus will keep an accurate and continuous check on your plant, and you can determine at any time whether or not you are getting the maximum efficiency. There are no floats used in the Hoppes V-Notch Meters and they are just as dependable at a high rate of flow as at a minimum rate.

The Hoppes V-Notch Meters are guaranteed to be accurate within 1½% by weight, for either high or low rates of flow and at any temperature of the water.

Our Catalog No. 70 will be of value to you. It gives illustrations and full descriptions. Write us concerning your requirements. We will gladly figure with you. Our service assures you complete satisfaction.

The Hoppes Manufacturing Company

70 Larch Street, Springfield, Ohio

SAVE COAL

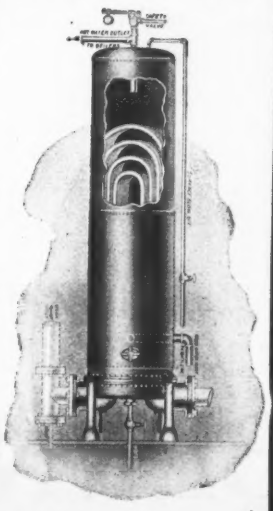
Use P.&C.(Davis) Feed Water Heaters

With the P. & C. (Davis) Feed-Water Heater you can utilize exhaust steam—that would otherwise be wasted—to heat water to 200 degrees or more BEFORE it enters the boiler, thus reducing fuel bills 10 to 15%.

In addition, you will add to the life and efficiency of the boiler, because this Heater frees water from all impurities except those which can only be removed by evaporation.

This means that boilers are kept clean and there is less scale; that there is no expansion and contraction of boilers caused by cold water; and that there is a saving in boiler repairs.

The P. & C. Heater also prevents oil and grease from entering and injuring boiler, as the steam and water do not come in contact with each other. Made in both vertical and horizontal types. Send for catalog fully illustrating and describing the full line.



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Manufacturers of Valves, Asbestos Packed Cocks, Feed-Water Heaters, Hot Water Generators, Hot Water Service Heaters and Power Pumps.

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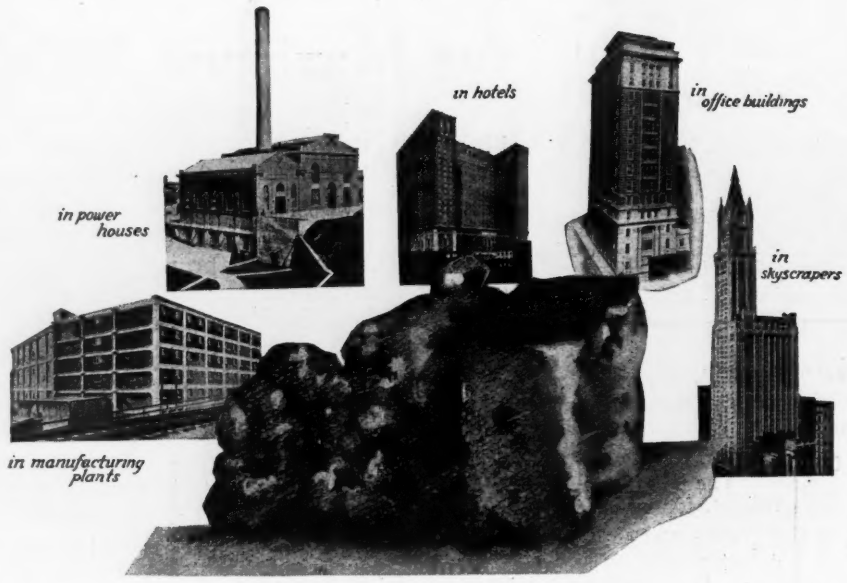

Is Slag Running Up Your Operating Costs?

Are clinkers adhering to the side walls of your boiler furnaces causing frequent shutdowns for relining, decreasing available grate surface, blocking free blower action?

The Bernitz Method of furnace wall construction (U. S. patents pending) lowers operating costs from these causes.

In many large boiler furnaces the Bernitz Plan is prolonging the life of furnace lining tenfold, is making always available every inch of grate surface, is absolutely preventing, clinker fusion with side walls.

This plan costs no more than ordinary methods of construction, yet by its use the furnace lining lasts years instead of weeks.

Details of the Bernitz Method of increasing the life of furnace walls will be sent you upon request.

BERNITZ FURNACE APPLIANCE COMPANY
15 STATE STREET, BOSTON, MASS.

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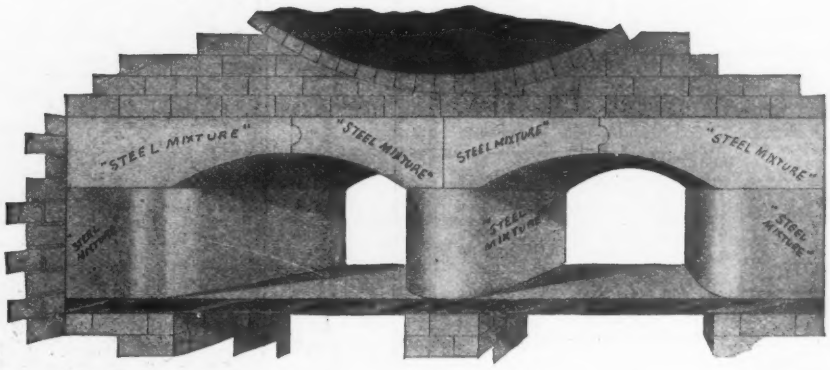
BERNITZ METHOD

Good Furnace Linings Are Essential



You can have no better protection for the front of your boiler furnace than an arch of this type. It is

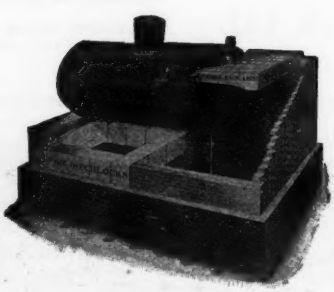
The Practical Boiler Door Arch

Note the smooth, flaring under-surfaces; the solid construction; the substantial foundation for the brickwork above.

It is simple in design as you can see. The cost of installing is therefore low. For the same reason it can be easily repaired or renewed.

Repairs are not necessary very often with a "Steel Mixture" arch, however. Neither are renewals. The material is made to stand just the kind of hard service that such an arch must meet. "Steel Mixture" arches last anywhere from two to ten years.

Write for a "Measurement Booklet" and see what it will cost to get an arch to fit your boiler. We ship at once.



Back Arches
Blow-Off Protectors

"STEEL MIXTURE"

Fire Box Linings
Furnace Roof Arches

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Win Your Business Battle

Handling of coal and ashes is a troublesome and costly matter to the power plant. We simplify it by cutting out waste of time, material and labor.

Boiler Houses that Boost Profits are our specialty—nothing else.

A "SPECIALTY" Installation. That's why we build a **better ultimate economy** into every power plant in which this vital problem is put up to us.

Let us show you **what we have done for others.** Then you will want us to find out what we can do for you.

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We design, manufacture and erect **Boiler House Equipment** for handling coal and ash.

Trenton and Allegheny Aves.

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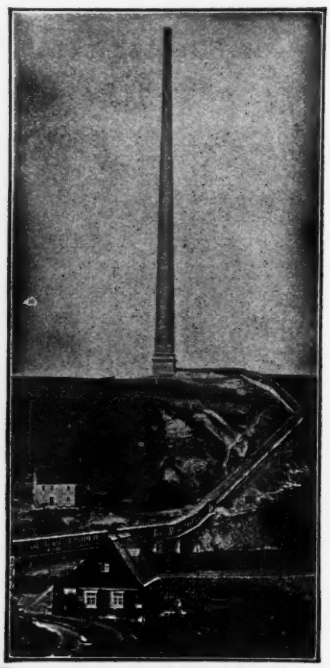
CHIMNEYS

RADIAL BRICK



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The most slender structure in the world—a Heinicke Chimney 460 ft. High by 8 ft. 3 in dia. at top}

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Showing ease with which Plibrico is laid in place.

SAVE COAL

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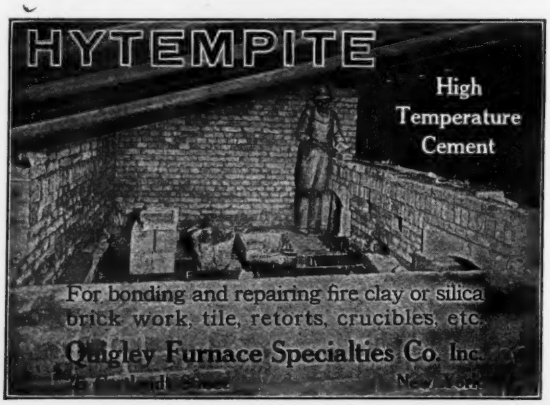
Highest Grade Fire Brick
Boiler Settings a Specialty

Plants in Pennsylvania, Ohio, Kentucky, Indiana and Alabama


HYTEMPITE
High Temperature Cement
For bonding and repairing fire clay or silica brick work, tile, retorts, crucibles, etc.
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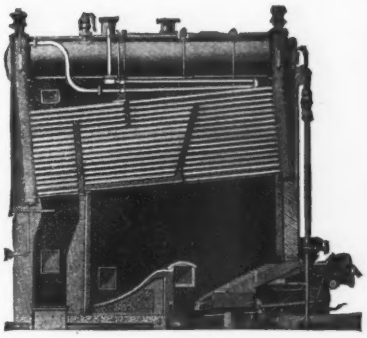
Gas-Tight Sloping Baffles

are necessary for the efficient and economical operation of water tube boilers.

The old idea that a square foot of heating surface in one part of the boiler is just as good as in another part is giving way to the scientific fact that it can only be made so by circulating the gases at a uniform velocity. This implies tapering passages and sloping gas tight baffles which are difficult to form with separate tiles or special blocks because of the necessary joints. But with



Horizontal, Vertical and Sloping baffles are easily formed, right in place, in any type or make of boiler.

BETSON'S

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PLASTIC FIRE BRICK

A few slats, a rod and a supply of Betson's is all you need.

solid one-piece baffles without joints that are gas tight are easily formed. The baffles may be given any shape or slope or angle desired to make those tapering passages for uniform gas velocity so necessary for high boiler efficiency.

No tools or forms are required in making Betson baffles. They are permanent, gas-tight baffles and will last as long as the boiler.

Write for our instructive Bulletin.

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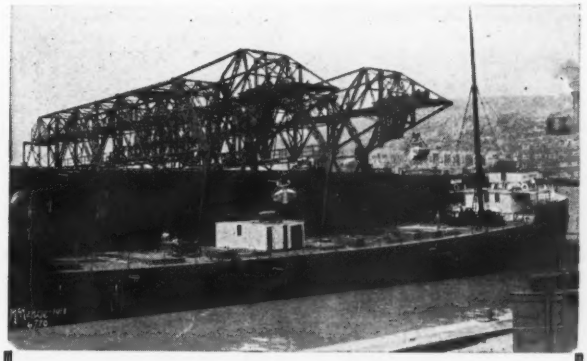

To Handle Coal Efficiently

thus saving labor, time and money is the main purpose of the

"LABRIDE" EQUIPMENT

With one man operating it, coal can be easily handled at the rate of 75 tons an hour.

The "Labride" is semi-portable and usable all the year around.

Ashes or any other materials can be moved with the same rapidity and low cost.

Let a "Labride" serve you as effectively as it has others. Write us for information.

Lakeside Bridge & Steel Co.

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SHEPARD ELECTRIC CRANES & HOISTS

FOR EVERY LIFTING SERVICE

To meet various handling requirements many types and capacities of Shepard Electric Cranes and Hoists have been developed, including 1 and 2-Motor Floor Controlled Hoists ranging in capacities from ½ to 10 tons.

Hoists for stationary service and for electrifying the hoist motion of hand cranes, are built in capacities up to 20 tons—Traveling Cranes up to 30 tons.

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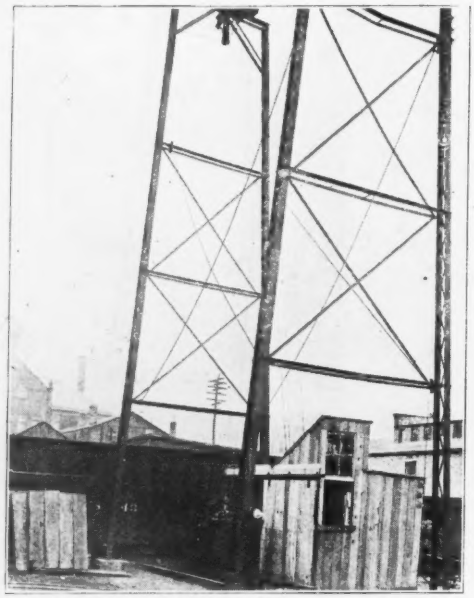


Shoot It
Through the Chute and the Godfrey Does the Rest

That's the way coal is handled by this gas plant at a cost of a few cents a ton.

A pit, a Godfrey Conveyor, and a chute from car to pit. The illustration shows its simplicity.

It's handling 80 ton a day with ease and **one man.** He's visible in the picture. In the shack is an electric hoist.

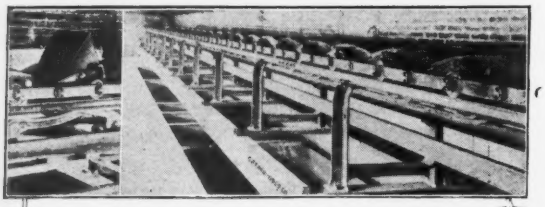
With this the 1-ton bucket is lowered into the pit, the gate of the chute opened and the bucket filled by gravity.

A touch elevates the bucket, sends it to the dump pile and back for another load. The man controls every move by levers.

Like all the Godfrey installations first cost is moderate, while operation and upkeep are negligible. The labor cost that is saved quickly pays the entire installation expense.

Any plant can handle its coal just as cheaply.
Write for our literature and learn the way.

The Godfrey Conveyor Company
Elkhart, Indiana



Handling Coal and Ashes
The **"G-W"** Way at the Illinois State Hospital, Elgin, Ill. This Equipment can be modified to fit your plant—Let us show you how. Get Bulletin 31.

Gifford-Wood Co.

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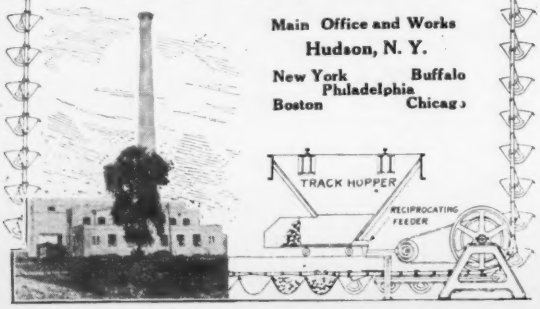

There's a Profit in Poor Coal
no matter how low the grade, if it is pulverized with

FULLER-LEHIGH
Pulverized Coal Equipment

Lignites and low-grade bituminous coals formerly considered of no value at all can be transformed into efficient fuels, at a large profit.

Beside utilizing fuel otherwise wasted, it lessens labor costs, eliminates smoke and increases plant capacity.

Plants using 25,000 tons daily are proving it.

Write for our Catalogue and we will tell you how they do it.

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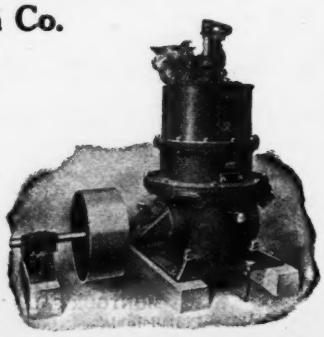
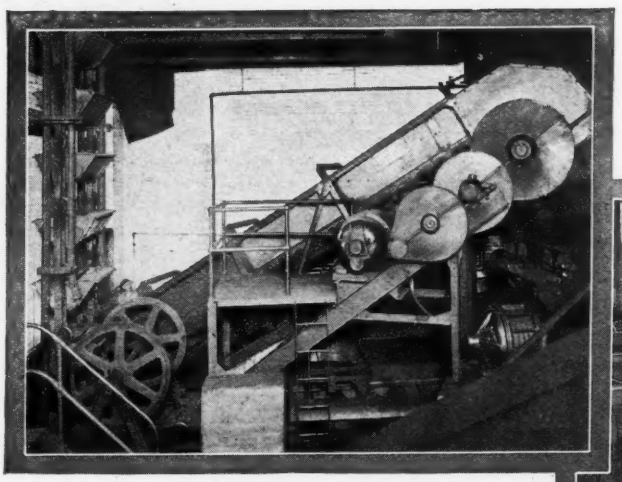
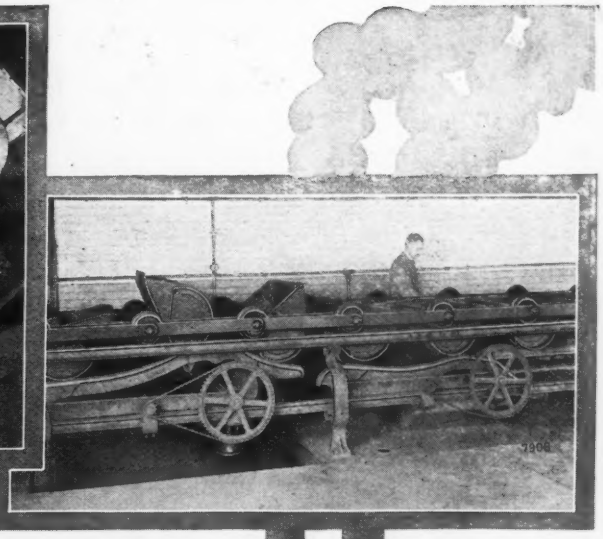


Fuller Mill Gear Driven. **PE**





Left View: Apron Feeder and Peck Carrier.
Right View: Horizontal Run of the Peck Carrier

The Peck Carrier

The standard machine for handling coal and ashes in the modern Power Plant handles coal in the Edison Illuminating Co's Boiler Plant, at Detroit.

The Peck Carrier is the highest development of the conveying art. Its uses and applications, already widespread, are constantly increasing. It is the *accepted standard* for handling coal, coke, ashes, cement, sand, stone, ore and similiar materials.

Let our experienced engineers cooperate with you when planning your new power house, or changing your old coal and ashes handling methods. Write for Catalog No. 220.

Power Plant of the Edison Illuminating Company, Detroit, Michigan.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

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281

LINK-BELT

Coal Handling Machinery

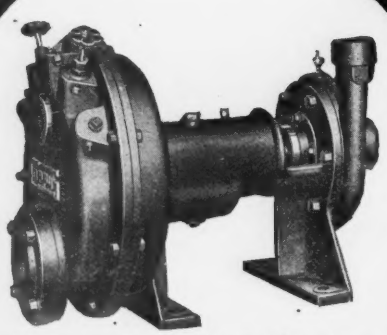
We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Locomotive Cranes
- ☐ Portable Loaders
- ☐ Coal and Ashes Systems
- ☐ Coal Pockets

Write for Catalogs
Place X in Square

"WE'RE PALS"

There are hundreds of other engineers and firemen with strong convictions on the worth of Coppus Turbo Blowers and Coppus Turbo Pumps. Hear what they have to say if you are in the market for a Blower. The Order of Pals is not yet entirely filled.



Coppus Centrifugal Turbo Boiler Feed Pump

REGIS

COP

U.S. PA

"Listen, Luther! I'm not saying you're selling a bum blower, but only that you can't sell it to me. When this new boiler is installed there'll be a Coppus Turbo Blower under it. The Coppus and me are pals, you may say.

"Prejudiced! Nothing of the sort, Luther. If I thought you were selling a better blower, I'd order it in a jiffy. But you see, I **know** your blower, and I **know** a good many others. I'm not **knocking** any of them. Just the same, I'm not ordering them. Not so's you can notice it, anyhow.

"Pals! You're not a K. P., are you? Never heard of Damon and Pythias, did you? They **were** pals —the real thing.

"What's that got to do with blowers? I'm coming to it, Luther.

"Listen, Luther! Everyone knows that for the last two or three years we've been rushed. Orders were stacked as high as your head. We worked three shifts, day and night. The boss began to get worried and talked of putting in another boiler.

"'Don't do it,' says I. 'We'll get along without it, and you'll save the money.'

"'How'll we do it?' says he. 'We'll have to have more power.'

"'Any time we need it,' says I, 'I'll give you twice what we're using now. What do you suppose I've got those Coppus Blowers for? I can double the loads on my boilers any time. Man,' I says, 'You've no idea of what forced draft will accomplish! Why, I'm like Paul Jones! I haven't begun to fire yet!'

"We didn't put in a new boiler then, but by the grace of the Coppus Turbo Blowers we filled every order we had and in good time. And we did it when lots of other plants fell down. **They didn't have** Coppus Turbo Blowers.

"I'm not saying it was any picnic, at that. You know what the coal situation has been the past few years. Some of the stuff we got disguised as coal was the limit. Everybody else got it, too.

"It was the Coppus Turbo Blower that saved us. All that was burnable in that stuff the Coppus enabled us to burn—to keep boiler loads up to the peak as long as we wanted them there. Kept the air supply ample and combustion just grand.

"Other fellows around here had blowers, too, but they couldn't burn the stuff they got and fell behind. If they had been Coppus Blowers—but that's another story.

"What happened? We made a reputation for efficiency that stuck! Our business has grown by leaps and bounds. It's become so big that we've got to expand our production and our facilities.

"And that's how the Coppus Blower earned the price of that new boiler.

"Sure! That's a Coppus Turbo Pump, another of my pals. You see, it's this way. When the Coppus salesman talked about this pump to me I turned it over in my mind, like this:

"Coppus has got a reputation on his Blower that can't be beat. Now he wouldn't dare to put his name on any old ordinary pump. He'd be too proud to, even if he had the nerve. What's the answer? He must have something in this Coppus Turbo Pump that'll stack up alongside his Blower for fair.

"I'll hand it to Coppus. **He has.** I'm using it on my boiler feed—it's a Centrifugal, you notice —but I could use it for half a dozen other things. When I say it's just as good as the Coppus Turbo Blowers I can't say anything stronger.

"Another thing, Luther. I'm not having any trouble about labor. I'm able to take my pick and get firemen that stick. They like to work with Coppus Blowers and Coppus Pumps. It saves them lots of hard labor and gives them a chance to rest now and then. In fact, they're pals of Coppus, too. Well, 'bong swore,' Luther. Call again."

Why not write for the Coppus Catalogue today? Our engineering department is at your service.

Coppus Engineering & Equipment Co.

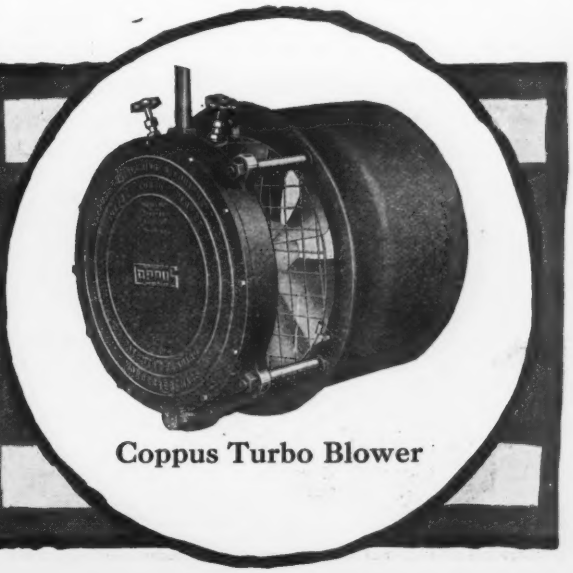
340 Park Avenue
Worcester, Mass.

Manufacturers of Coppus Turbo Blowers, Coppus Turbo Feed Pumps and Coppus Power Turbines

STERED

PUS

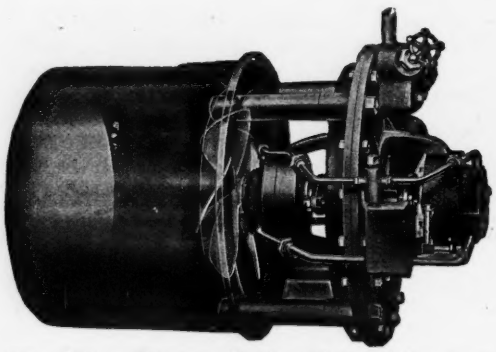
T. OFFICE



Coppus Turbo Blower

In these days, when
"Anything That's Black Is Coal"

and you take what the coal man gives you and try to be thankful for it, even at a "fancy" price, the right kind of mechanical draft will pay as it never has paid before.



The Original **Wing** Turbine Blower The Standard

will give you the "right kind" of mechanical draft, regardless of wind or weather, and it will enable you to boost your boiler capacity by 25%, 50%, perhaps even 100%, even burning the cheapest grades of coal.

Nobody knows how long you'll have to wait for more boilers—how long the delays in transportation and installation. Get the extra needed hp. out of your present boiler equipment—without long delay and at low cost—by installing Wing Turbine Blowers.

The **Wing Blower Book** substantiates every claim we make, contains a brief history of the development of mechanical draft, a detailed description of **Wing Turbine Blowers** and a lot of valuable data on this subject. Ask for your copy now.

L. J. Wing Mfg. Co.

659-669 Hudson St., NEW YORK

Manufacturers of Ventilating Fans, Blowers, Damper Regulators, Pressure Blowers, Vacuum Pumps and Small Turbines.

ECONOMICAL **Carling** BLOWERS

Carling Turbine Blowers

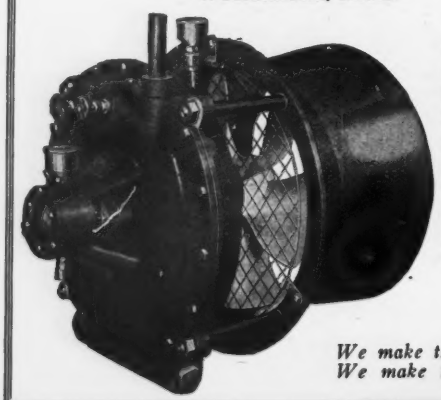
For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products. Write today. Try at our expense.

Carling Turbine Blower Co.

Engineers and Manufacturers

WORCESTER, MASS.

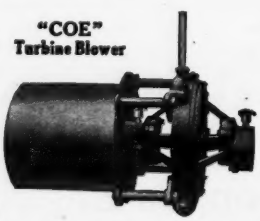


Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines,

We make them safe.
We make them strong.

Cut Coal Cost

"COE" Turbine Blower

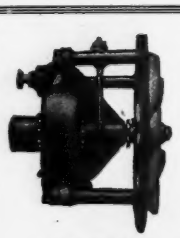


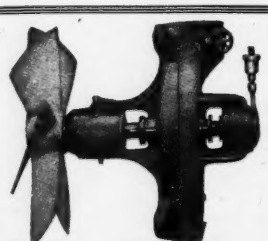
and increase boiler capacity, regardless of weather conditions or grade of fuel by installing

"COE" TURBINE BLOWERS

under your boilers. Write for bulletin showing many superior features which make for long life, trouble-free operation and minimum steam consumption.

C. T. Coe Company CHAMBERSBURG PENNSYLVANIA





Simplex No. 3 **Casings Removed** **Power No. 2**

TURBO BLOWERS

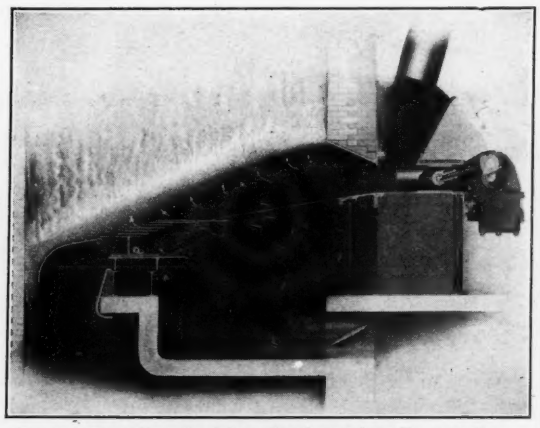
Turbines—Damper Regulators—Turbo-Pumps

POWER TURBO BLOWER CO.

Madison Ave. and 45th St., New York

710 Witherspoon Bldg., Philadelphia **140 S. Dearborn St., Chicago**

The Canada Stoker Co., Ltd., Galt, and 15 Rusholme Rd., Toronto, Ontario, Canada.



Cross-section through stoker showing automatic operation.

RILEY UNDERFEED STOKERS

It is not only the things the RILEY STOKER does, but the way it does them. For instance, when steam is wanted quickly and time is precious, you can get this steam instantly and economically by increasing the motion of the grates.

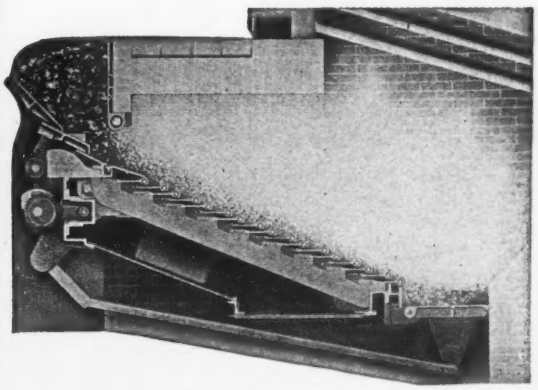
With the first turn of the cranks the grates start moving—the whole fuel bed is thrown into action. There is no watching nor waiting—poking or slicing—the stoker responds instantly and in two or three minutes the boiler will be operating at 200 or 250 per cent of rating.

Catalog PE-12 shows how it is done.

Sanford Riley Stoker Co.

WORCESTER, MASS.

British Licensees: Erith's Engineering Co., Ltd., London. French Licenses: Erith, Leroy & Cie., Paris, France.



Automatic Control

Furnaces must be fed with coal and air that is controlled by automatic means which cannot fail. Hand methods never give complete satisfaction. The

LEHIGH FORCED DRAFT STOKERS

feeds fires with absolute accuracy, and makes possible almost perfect combustion, even though the coal is of a very low grade.

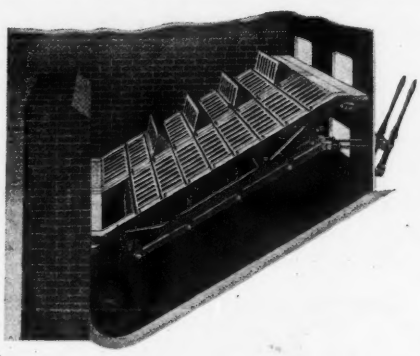
Clinker adhesions are prevented by water-cooled grate bars, while heat used helps heat boiler feed.

Coal and labor is saved and maintenance cost is low.

Write for catalogue, which gives full information.

FULLER-LEHIGH CO., MAIN OFFICE FULLERTON, PA.

New York, 50 Church St. Chicago, Ill., 1336 McCormick Bldg.
London, 25 Victoria St., Westminster, S. W. I.
San Francisco, Cal., 719 Sheldon Bldg.
Seattle, Wash., 714 L. C. Smith Bldg.
Herrn Claudius Peters, Hamburg I, "Wallhof," Glockengiesserwal 2, Germany.



The VASIL HAND STOKER

GUARANTEES

1. To evaporate 10 lbs. of water (from and at 212° F.) per pound of dry coal.
2. To increase rated capacity of Boiler from 30% to 75%.
3. 70% combined Grate and Boiler efficiency with Boiler in good working condition. (Above are based on dry coal containing 14,000 B.t.u.'s per pound).
4. Eliminate necessity of cleaning and slicing fires by old method.
5. To reduce customary smoke from 75% to 90% and comply with the requirements of the Department having jurisdiction over same.
6. A saving of at least 10% in fuel.
7. A saving of 40% in labor.

A letter to us will bring you, by return mail, full particulars and illustrations of the Vasil Stoker, together with such other detailed information as you may request relating to its adaptability to your individual requirement.

THE VASIL STEAM SYSTEMS CO.

WASHINGTON LOAN & TRUST BLDG.

Pittsburgh, Pa. WASHINGTON, D. C. Boston, Mass.

Built Complete in Our Own Plant

Harrington Traveling Grate Stokers
Brady Steam Jet Ash Conveyors
Brady Flat Arches
Reliance Automatic Coal Scales

Jas. A. Brady Foundry Company

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CHICAGO

ORIGINAL HAND STOKER

HUBER HAND STOKER

PATENTED

Sole Manufacturers

FLYNN & EMRICH CO.

Established over 70 years

Baltimore, Maryland

They Used to Spot the White Man By his Fire's Smoky Waves Now they Spot the Files Stoker By the Smoke its Fire Saves

Smokeless stacks are the eloquent signs of **Files Stokers,** Hand Operated. They are the outward evidence of furnaces that burn and convert coal **into power only**—later **into profits.**

The stacks shown below **are not** related to **Files Stokers,** Hand Operated. **Horrible examples**—are they not?

Files Stokers, Hand Operated, are **real combustion machines,** giving the same high efficiency as mechanical stokers.

At much less expense. Cost less to install. No expensive coal and ash handling equipment required. No remodeling of plant. It takes only a few days to install the **Files** under **any** furnace where coal is burned.

A fireman and the levers do the rest with closed fire doors. The

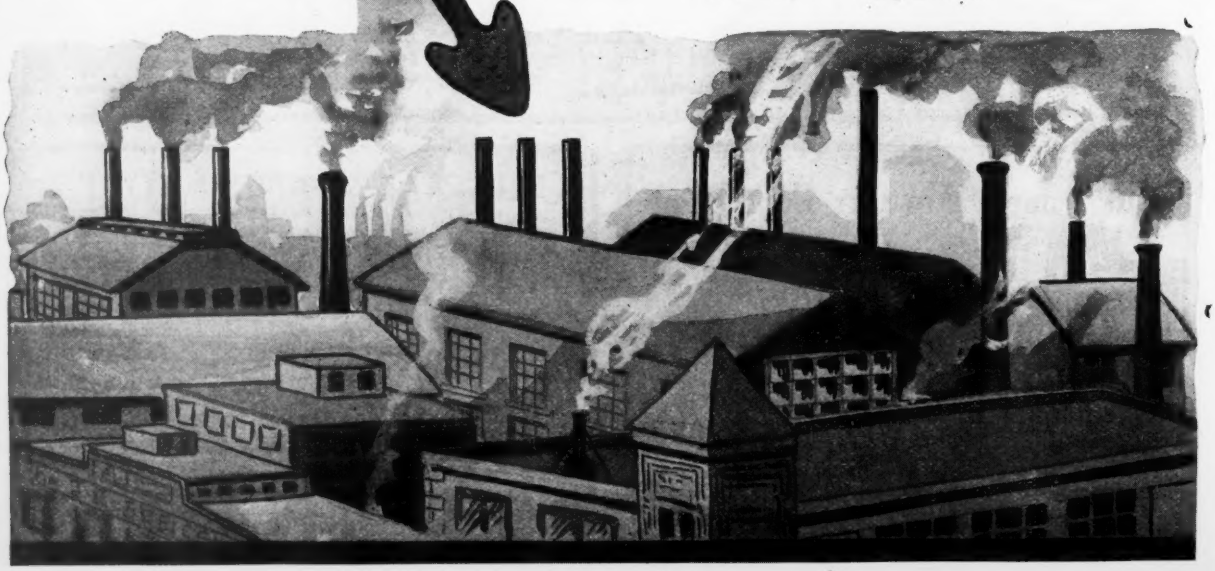
FILES STOKER Hand Operated

by maintaining continually clean fires, with proper distribution of air and fuel insures complete combustion; eliminates the periodical cleaning of fires, with the dirty arduous work involved and enables heavy overloads to be met at any time.

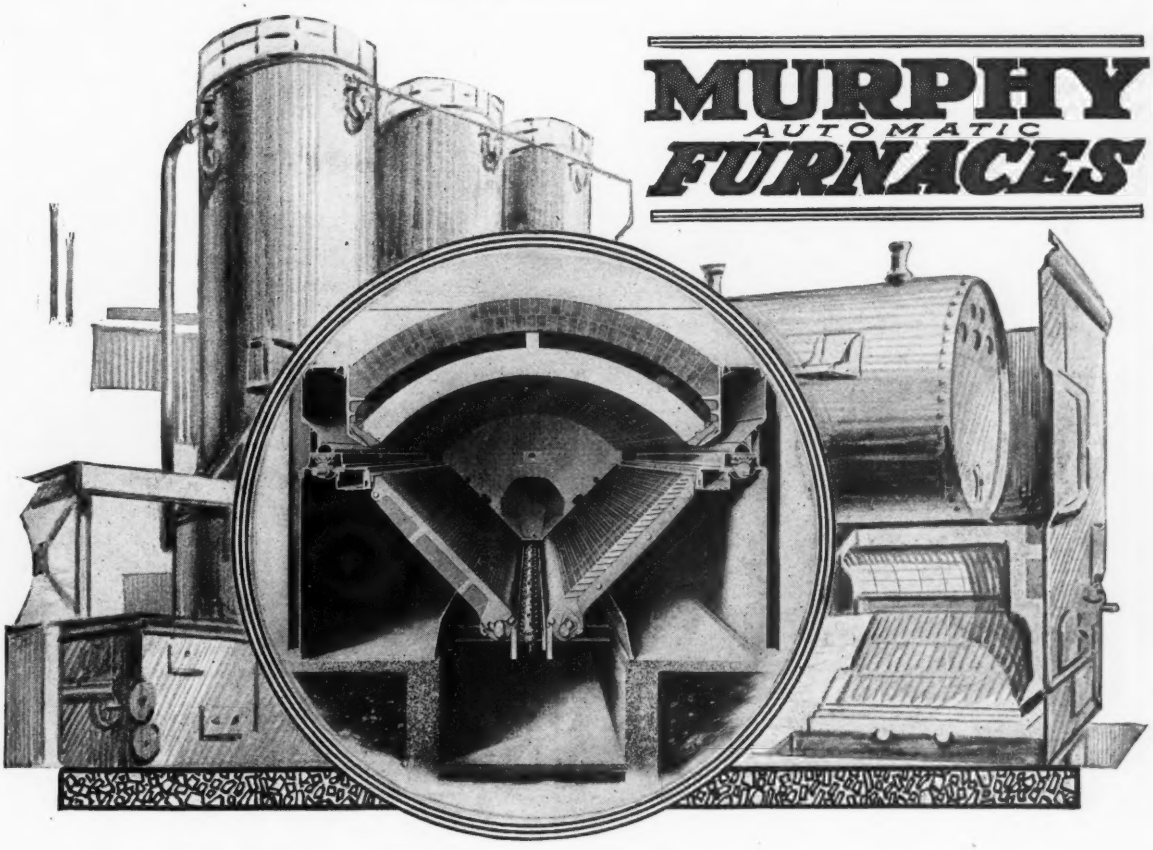
With the Files you can get the high combustion efficiency of expensive mechanical stokers with lowest installation and maintenance costs.

Write for bulletin

THE FILES ENGINEERING CO., INC.
75 Westminster St., Providence, R. I.
Branches in Principal Cities



For any type of Boiler



Any boiler from 50 H.P. and up can be equipped with the **Murphy Furnace.** The smaller plant can therefore enjoy all the economical advantages of the larger plant without resorting to forced draft.

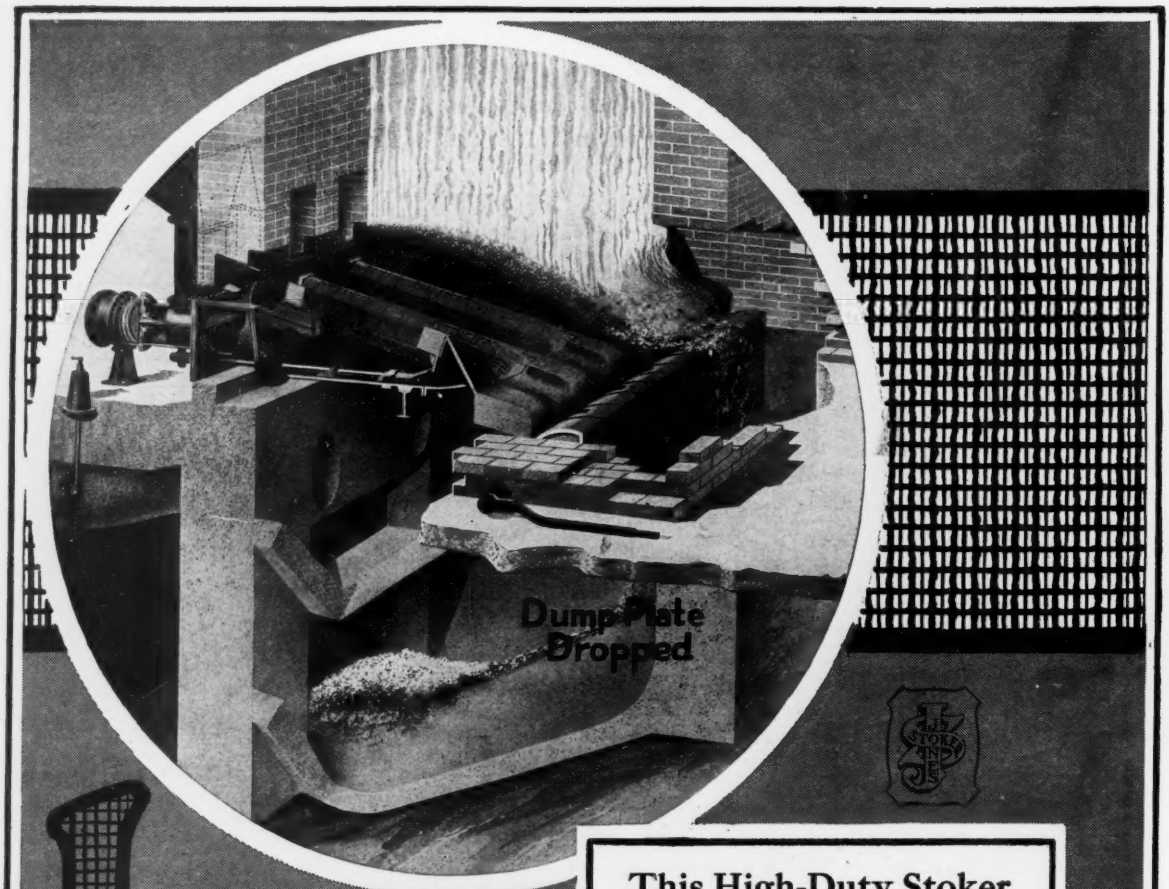
The money you save on auxiliary equipment goes far toward paying for an installation of Murphy Furnaces.

Couple Natural Draft with Murphy ability to *burn any fuel that has heat in it* and you have a simple explanation of Murphy economy in hundreds—yes, thousands of plants.

If your boilers are 50 H.P. or larger you should write us. Catalog PE-12 places you under no obligation. Send for copy and see how easily the Murphy Furnace can be installed under any type of boiler.

MURPHY IRON WORKS, Detroit, Michigan

BURN ANY FUEL THAT HAS HEAT IN IT



Jones "A-C"

write for the new catalog

This High-Duty Stoker

—*saves labor* because its operation is entirely automatic. No hand-cleaning is necessary.

—*saves coal* because the automatic controls supply the correct proportion of air and fuel for complete combustion. There is no smoke.

—*prevents clinkers.* There are no clinker formations either on the bridge wall or on the side walls.

—*holds even steam pressure* at all times, regardless of sudden changes in the load.

—*has high over-load capacity* and extreme flexibility because of the wide range of operation.

—*is simple in design* and so sturdy in construction that maintenance costs are extremely low.

The Under-Feed Stoker Co. of America
MAKERS OF THE JONES STOKER
General Offices: Book Building · Detroit

Boston	Cincinnati	Minneapolis	St. Louis
Buffalo	Cleveland	New Orleans	Salt Lake City
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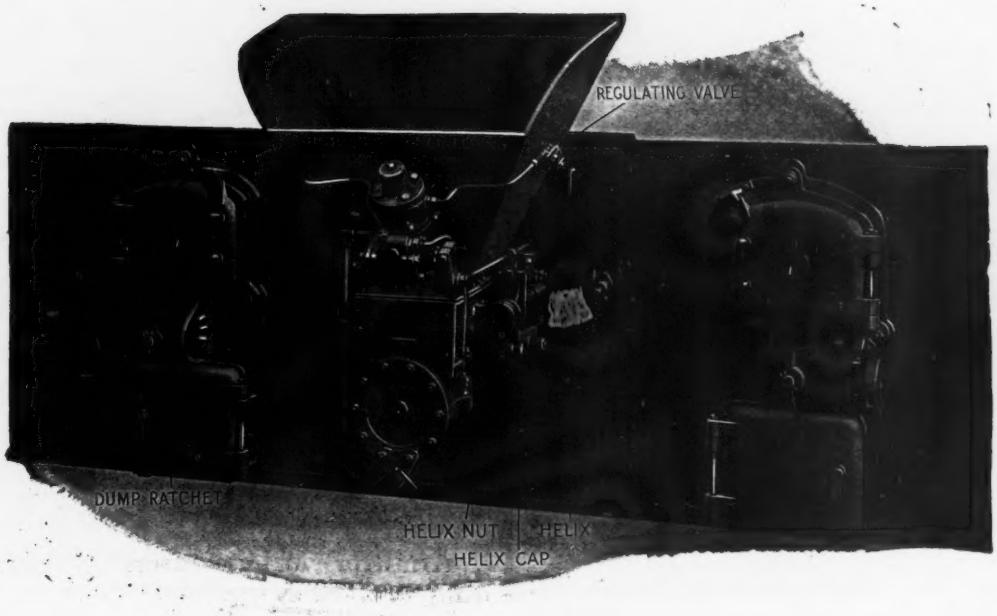
Pays for Itself-then Pays Dividends

STANDARD



TYPE E STOKERS

Simple and dependable. No matter how poor the coal is they keep going.

They Are the Recognized Standard

Combustion Engineering Corporation
11 Broadway, New York City

Owners and manufacturers of

Type "E" Stokers—For Bituminous Coal. The Grieve Grate—Hand-Firing Coxe Stokers—Anthracite Coal Coke Breeze and All Low Grade Fuels

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BIRMINGHAM, ALA. HAZLETON, PA. BOSTON, MASS.
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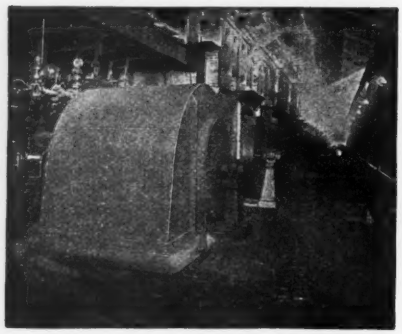
OMAHA, NEB. ALBANY, N. Y. DENVER, COL.
TAYLOR ENGINEERING CO., VANCOUVER, B. C.



YOU can take care of sudden demands for more power promptly and positively if you, with Mechanical Draft, Buffalo Stoker Fans, induced Draft or Forced Draft fans, insure economy.

Write for Catalog 420-64

BUFFALO FORGE COMPANY
Buffalo, N. Y.
Offices in all principal cities

"Buffalo"

EASE OF OPERATION

is only one of the good points of the

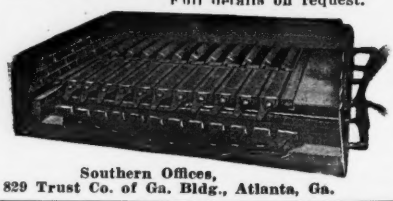
CANTON Rocking and Dumping Grates

Another is ease of installation.

Inasmuch as it burns the worst of coal well the Canton is a great aid to power plant economy.

It is also a labor and trouble saver, for, being simply yet stoutly constructed, it does not easily get out of working order. No loss of heat when stoking.

Full details on request.



CANTON GRATE COMPANY
1708 Woodland Avenue, Canton, Ohio

Southern Offices,
829 Trust Co. of Ga. Bldg., Atlanta, Ga.

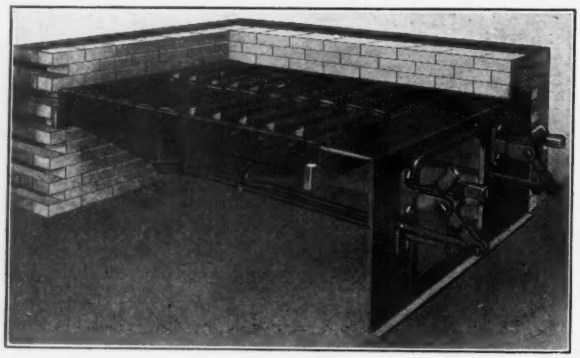
Increase Boiler Capacity

Armstrong grates increase boiler capacity 25 to 40 per cent as every inch of air space can be left open without coal loss.

The "Armstrong" is an ash sifter, vibrating grate, shaking grate, and dumping grate combined. This means an enormous saving in time, labor and fuel. Clinkers 6 inches thick are dumped entire. Larger ones are crushed. Everything is simplified. The maintenance cost is low, and long dependable service is certain. Learn all about Armstrong grates from our catalog. Put in on trial with any grate made at our expense.

Patented:
Jan. 12, 1915.
Jan. 25, 1916.

Armstrong Manufacturing Co. 252 Ludlow Ave., Springfield, Ohio



"Fits My Idea of Great Efficiency"

That's what you'll say after you know the facts about a

NEEMES GRATE

Highly efficient because it makes for more perfect combustion of every pound of coal fed to it, thus permitting better results from cheaper coal and also a reduction in the amount of fuel used.

Shakes out the ashes; cuts out the clinkers; dumps the fire.
Write today for full particulars.

NEEMES BROS.

186-196 1st Street Troy, N. Y.

MANUFACTURERS OF ROUND AND SQUARE GRATES

Babcock & Wilcox, Ltd., Montreal, Canada, Sole Makers for Canada. Burke Engineering Co., 525 Industrial Building, Providence, R. I., Sole Agents for the New England States.
C. F. Catillaz, 30 Church Street, New York.

Shear Klean Grates

are very successful for **Malleable Iron Ovens** and for burning coke.

Bars are almost a semi-steel mixture, very durable. Will not warp. Practically indestructible with coal. They shear the clinker and keep the fire clean.

Every user a booster.

Shear-Klean Grate Co.

809 Monadnock Block Chicago, Ill.

Central Station Economy

Some large central stations, as well as many small plants, have been saving coal, labor and burning cheap grades with

HERRICK Shaking Grates

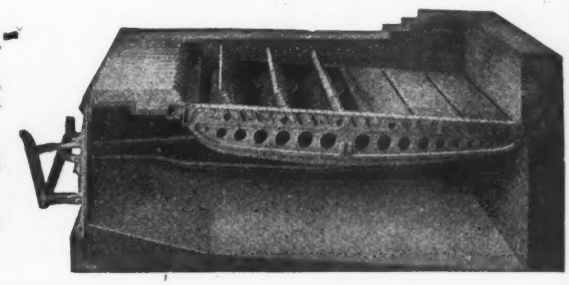
The large plants put them in because of the fuel savings they made; the small one because of this, and the low investment they represent.

"Stands on It's Own Feet"

Either reason would warrant you sending for a copy of "A Grate Proposition," sent free.

GEO. S. HERRICK
SYRACUSE, N. Y.

DON'T DELAY a Minute in Learning What McClave Combustion Service Will Save in YOUR PLANT



McClave Grates and Argand Blowers

—a combination that will beat any coal combination

For 35 years McCLAVE GRATES have been furnishing fuel beds to power plants that were most perfectly adapted to the proper combustion of the cheap, waste and little used grades of coal.

Put a McCLAVE GRATE under YOUR coal.

For two generations ARGAND BLOWERS have supplemented natural draft, so that the cheaper grades of Anthracite or Bituminous gave results as good as the best.

Put ARGAND BLOWERS under McCLAVE GRATES in Your Plant.

Write for the facts today. Avoid disastrous shutdowns. Just write on your letterhead: "Send me Catalog D," or USE COUPON BELOW. Do it NOW.

McClave-Brooks Co., Scranton, Pa.

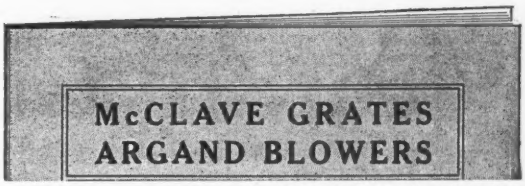
NEW YORK OFFICE:
Room 351, 50 Church Street
S. C. Smith, Manager

PHILADELPHIA OFFICE:
400 Morris Building
George Blair, Jr., Manager

CHICAGO OFFICE:
515 Hearst Building
F. G. Smith, Manager

NEW ORLEANS:
951 North Carrollton Ave.
D. W. Robertson, Rep.

Get this Book of Facts →



Fill Out and Mail this Coupon →

....., 1919.

McClave-Brooks Co., Scranton, Pa.

Without obligation, I wish to know about McClave Grates and Argand Blowers. Send me your Catalog D at once.

Name .....

Street and No.. .....

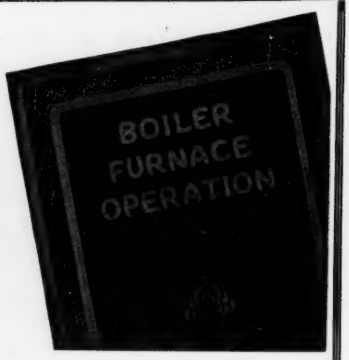
City .....

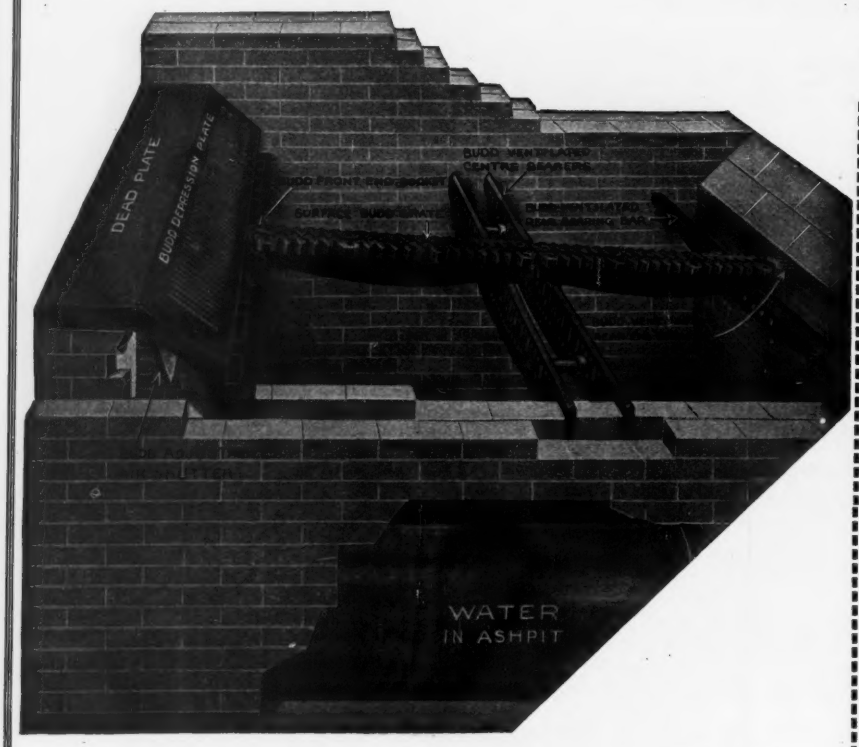
State .....

Firm .....

Have You a Copy of Boiler Furnace Operation

This valuable book gives you information as to the efficiency and good combustion in your furnaces. A copy of this book will be sent to you **free** by your filling out the coupon below and mailing to us.





Budd Grates

and many other kinds of grates and furnace equipment are, manufactured by our Company. Wherever you are locatedt the Budd Engineering Dept. can be of assistance to you. I certainly will not cost you anything to investigate further

Tne symbol of superior castings: "H. R. Budd Grate Co., Philadelphia." The castings bearing these letters are composed of the famous Budd Heat-Resisting Iron.

There are a number of vacancies open for exclusive representatives. If interested, write requesting proposition.

BUDD GRATE COMPANY

Offices: 2011-13 E. Letterly St.
Works: Adams to Letterly Sts.
Philadelphia, Pa.

——Send in the Coupon——

The Budd Grate Co.,
Philadelphia, Pa.

Please mail me a copy of your book "Boiler Furnace Operation."

I am interested in items opposite which I have placed a check.

- ☐ Patterns to cover blue prints or sketches, make castings of brass, iron, bronze, aluminum, or any other composition metal and machine same to a finished product.
- ☐ Bushings, Bearings
- ☐ Rear Combustion Chamber Arches
- ☐ Boiler Doors complete to meet any requirement.
- ☐ Front Arches
- ☐ Shaking Grates
- ☐ Stationary Grates
- ☐ Dumping Grates
- ☐ Covering Bars
- ☐ Buckstays
- ☐ Dead Plates
- ☐ Door Liners
- ☐ Floor Plates

Name .....

Street & No.....

City & State.....

.....

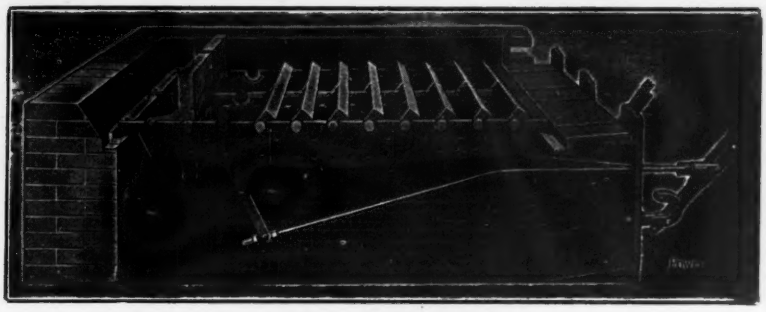
.....

TRADE MARK KELLY GRATES GOSHEN IND.

Deduct 10% From Your Coal Bill

TRADE MARK KELLY GRATES GOSHEN IND.

Easy To Install



Easy To Operate

Plate No. 22, Style "B"

KELLY ROCKING AND DUMPING GRATES are built with correct percentage of air space to suit furnace conditions and fuel burned. They will save not less than 10% of your coal, compared with stationary grates.

Their design is simple and substantial. All moving parts are so constructed that they will not warp and jamb.

No special furnace construction is necessary and no parts of the KELLY grates are built into the brick work. They are supported at the front and rear of the furnace by regular grate rests.

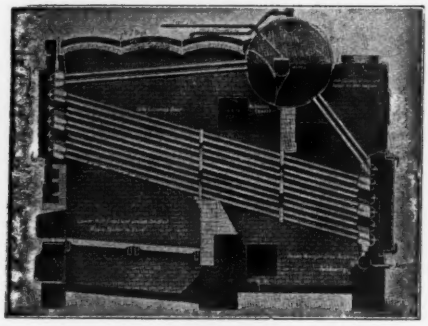
Our Grate Catalogue 'C" explains.

WHEN YOU BUY KELLY GRATES YOU BUY RESULTS!

The Kelly Foundry & Machine Company, Goshen, Ind.

Established 1887 Power Plant Engineers 617 Ninth Street

New York Office, 59 Park Place 'Phone Barclay 7030



Springfield Water Tube Boilers

Sectional-Sinuous Headers. All Steel Construction

No Staybolts No Braces No Bent Tubes

Each section suspended independent of all other sections.

Hand holes have inside plates of drop forged steel, each covering four tubes.

65% less hand hold than other horizontal W. T. boilers.

Occupy less space and require less brick than other horizontal W. T. boilers.

Baffles are indestructible and permit removal of any tube without disturbing other tubes or baffles.

And many other special features.

Write for catalog and detailed information.

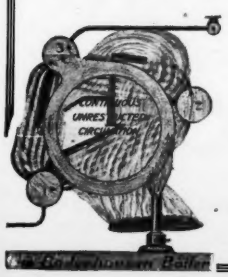
Springfield Boiler Company

Springfield, Illinois

THE *Badenhausen* BOILER

HAS Continuous and Unrestricted **CIRCULATION**

GIVES Dry Superheated Steam, High Constant Efficiency, Complete Satisfaction



IS BUILT

BY Badenhausen Co.
AT Cornwells, Philadelphia, Pa.
IN Shop containing world's best Boiler-Making Tools

Send for catalogues. Let our engineers look over your requirements.

BADENHAUSEN CO.

1425 Chestnut St., Philadelphia, Pa.

Works:

Cornwells, Pa. Bound Brook, N. J.

New York, 112 Broadway; Pittsburgh, Jenkins Bldg.; Chicago, 1225 Marquette Bldg.; Denver, 211 Tramway Bldg.; San Francisco, 411 Rialto Bldg.; Birmingham, Ala., Brown-Marx Bldg.

THE EDGE MOOR WATER TUBE BOILER

Especially Suitable for Large Power Plants

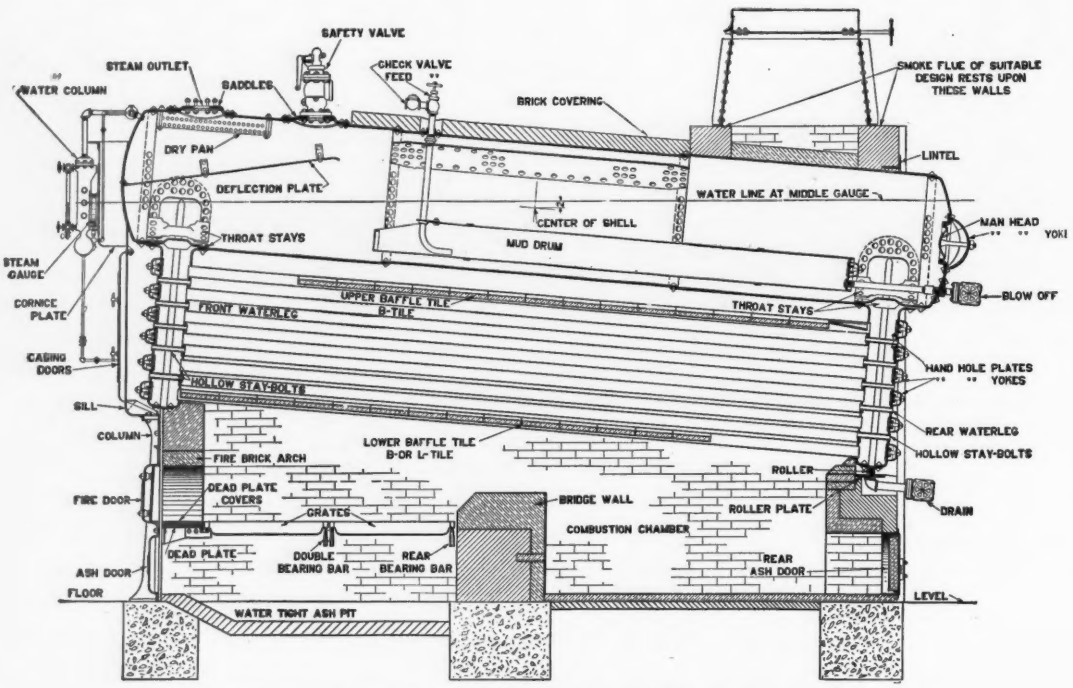
Steel construction throughout. Straight tubes. All hand-holes elliptical, their covers internal and removable through their own openings. Unrestricted circulation, permitting forcing of fires with safety and economy.

Send for Bulletins on Performance

EDGE MOOR IRON COMPANY

EDGE MOOR, DELAWARE

BOSTON NEW YORK CHARLOTTE, N. C. CHICAGO



Cross-section of Heine Boiler and setting showing simplicity of the construction

Required for Efficiency—Heine Boilers

Heine design is fundamentally correct,—the horizontal passage of furnace gases, the ample combustion chamber, the mud drum to minimize formation of scale, and the water legs permitting quick and complete cleaning of tubes.

"Some of the principal losses (in the average boiler room) are due to improper design of the plant equipment, failure to keep the internal and external surfaces of the boiler free of scale and soot accumulation, and failure to keep baffle walls, furnace walls, and other parts of the boiler setting tight and in first-class condition."—POWER, P. 331, Aug. 26, 1919.

On Heine Boilers all maintenance work is done from the ends—front or rear. Any number of boilers can be built in a single battery. With Heine design no openings are required in the side walls. This feature practically eliminates the inleakage and infiltration of air due to side-openings.

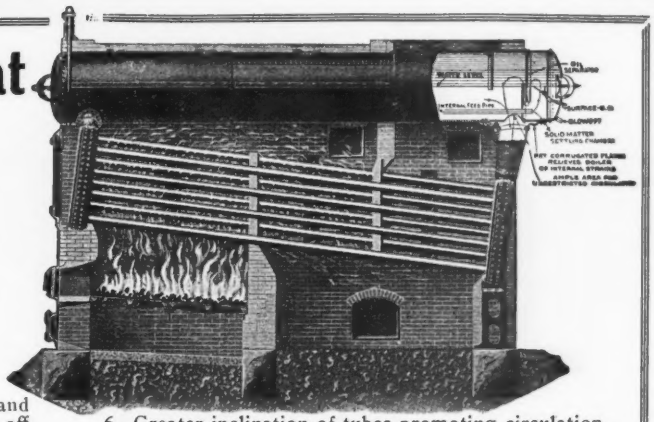
All Heine Boilers are fitted with a blower system, using jets of steam. With this dust and soot can be dislodged quickly and effectively. The nozzles for the blower are inserted in the hollow stay-bolts shown in the water legs in the above drawing.

Other fundamentals of good boiler design are explained in the Heine Treatise "Boiler Logic." Send for your copy.

Heine Safety Boiler Co.

5318 Marcus Avenue **St. Louis, Mo.**

Exclusive Features that SAVE FUEL



To keep down rising costs look to your boilers, the equipment above all others in the plant which determines profit or loss.

Union Water Tube Boilers combine:

1. Economy in operation.
2. Reliability of service.
3. Overload capacity.
4. Safety.

The reasons back of their record of better performance are found in the Union features:

1. Horizontal drums—liberating surface, dry steam, water storage capacity.

2. Purifier in drums, settling chamber out of fire and circulating element, provided with reinforced blow-off connection.

3. Corrugated flange connection from drums to headers, no restricted area, good circulation, relieving boiler of internal strains.

4. Headers made in integral halves in one heat, of ample depth, no double plates or rivets exposed to fire, regular, not irregular pitch of staybolts. Shape of hand-hole, easily kept tight. Additional blow-off bottom of headers.

5. Handhold plates of steel plate, each removable through hole it covers, no fishing, yoke of novel design, quickly removed.

6. Greater inclination of tubes promoting circulation, vertically staggered, horizontal spacing to permit proper cleaning on fire side. Ample gas passage areas.

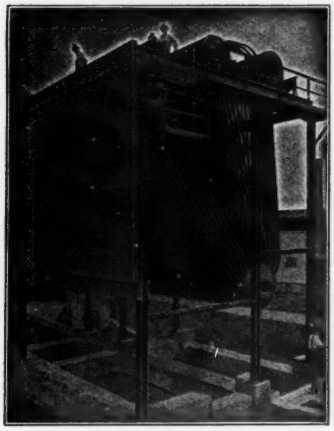
7. The very best workmanship that can be done by a well-trained organization and modern facilities.

8. Continued operating efficiency and greater overload capacity than any other boiler, due to the combination of these features, resulting in less time required to clean boiler when necessary, longer period of continued efficient operation, minimum loss of time out of service.

Let our district engineer show you how to keep down rising costs. Catalog on request.

UNION IRON WORKS 1400 Cascade St., Erie, Pa.
ESTABLISHED 1889

UNION Water Tube BOILERS



Connelly (Patented) Water Tube Boilers

are of the 4 drum type, have 100% tube area in the path of the circulation, and deliver steam superheated 5 to 10°

Simple in design, have no flat surfaces, no stay bolts, no crown bars, or braces and free from hundreds of joints—no handholes.

Easily accessible for cleaning internally and externally.

Can be built in units up to about 4000 H. P. and 300 lbs. pressure.

Write for Our New Catalogue, Desk 7.

The D. Connelly Boiler Company, Cleveland, Ohio

Founded in 1875 by Daniel Connelly

Babcock & Wilcox—Stirling—Rust

Water Tube Steam Boilers

Steam Superheaters **Mechanical Stokers**

The Babcock & Wilcox Company

85 Liberty Street, New York **Works: Barberton, Ohio; Bayonne, New Jersey**

		BRANCH OFFICES:			
Atlanta	Candler Building	Denver	435 Seventeenth St.	Philadelphia	North American Building
Boston	49 Federal St.	Havana, Cuba	Calle de Aguiar 104	Pittsburgh	Farmers' Deposit Bk. Bldg.
Chicago	Marquette Building	Los Angeles	L. N. Van Nuys Building	Salt Lake City	705-6 Kearns Building
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HORIZONTAL TUBULAR BOILERS

We also build and carry in stock a complete line of

Uprights, Locomotives, Empire Return Tubular, Portable and Water Tube Boilers

AMES IRON WORKS *Write for Bulletins*
Main Office and Works: **Oswego, N. Y.**

LADD
WATER TUBE BOILER

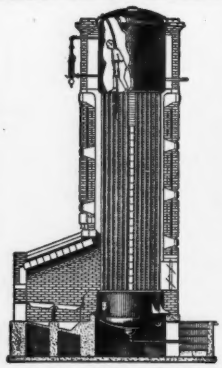
THE LADD
WATER TUBE BOILER

is a vertical boiler of simple construction developed to a point where it can be successfully built in all sizes from the smallest practicable unit to one of over 3,000 horse power in a single setting. A large number of combinations of height and width can be furnished and the boiler can be adjusted to meet great variations in space conditions.

The George T. Ladd Company has adopted the standards laid down by the Code of the American Society of Mechanical Engineers. This obviates any discussion of the strength of the parts of a Ladd Boiler or the question of its installation anywhere.

Our Bulletin will be sent on request.

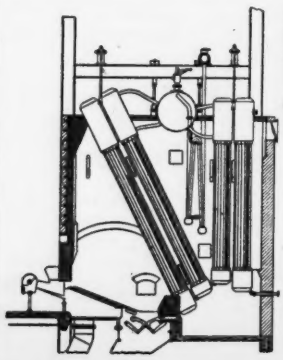
The GEORGE T. LADD COMPANY
1621 Farmers Bank Building
PITTSBURGH, PA.


Man Stands Erect Cleaning

Wickes Vertical Water Tube Boilers

Ever cleaned a boiler, lamed your back, bruised your knees and skinned your elbows doing it? Two men can open, wash, close and fill the WICKES in five hours. Turbine in ten hours.
Ask for Bulletin—Reducing Costs in Boiler Room. Sent Free.

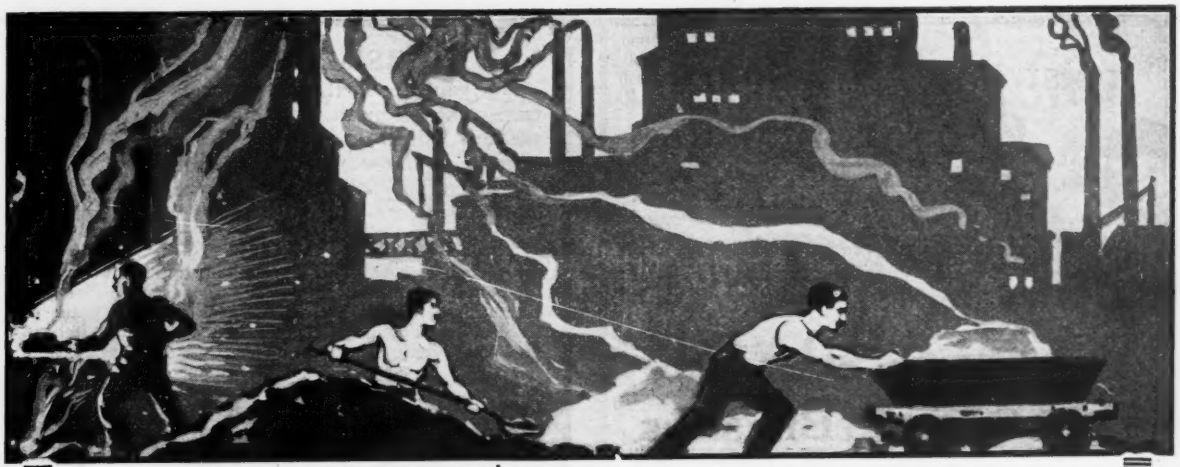
The Wickes Boiler Company
Saginaw, Michigan, U. S. A.
SALES OFFICES:
New York City, 1716 West St. Bldg.; Chicago, 76 West Monroe St.; Pittsburgh, 1218 Empire Bldg.; Boston, 201 Devonshire St.; Detroit, 1116 Penobscot Bldg.; Seattle, 736 Henry Bldg.



BIGELOW-HORNSBY
Water Tube Boilers

Straight Tubes. No Hand Hole Plates. Units up to 3000 Horsepower. Manufacturers of Bigelow Manning and H. R. T. Boilers.

The Bigelow Company
28 River Street, New Haven, Conn.
Boston Office, 1001 Oliver Bldg.
New York Office, 928 Singer Bldg.
Southern Office, Realty Bldg., Charlotte, N. C.

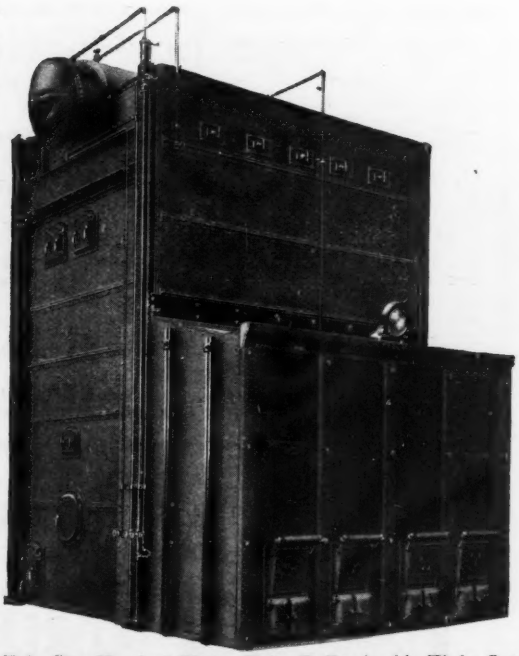


Crucibles of Power

Above the roaring fires water is confined and steam generated that, harnessed to the purposes of man, gives a constructive power that builds the commercial supremacy of a nation.

ERIE CITY BOILERS

are the crucibles in which this power is being generated in thousands of leading power plants the world over. They are easily developing the over-capacity that meets the tremendous over-loads being thrust upon them.



Erie City Vertical Water Tube Boiler in Air Tight Setting

ERIE CITY Boilers are giving this increased power with a minimum of fuel. Every exclusive feature gives a greater strength and a greater economy of operation.

In the **ERIE CITY Vertical Water Tube Boiler** the two large horizontal drums give dry steam, quickly and economically; permit a large liberating surface and storage capacity, and, with the **ERIE CITY** arrangement of tubes, allows each tube to expand and contract independently, as well as making cleaning easy.

The modern construction of the **ERIE CITY Boiler** makes it exceptionally efficient in the conservation of time, fuel and labor. It provides for burning of all kinds of fuel—coal, oil or gas.

These are some of the excellent reasons why **ERIE CITY Boilers** excel and are favored by good engineers. Our literature shows others. Send for it—TODAY.

ERIE CITY IRON WORKS

1510 East Ave., ERIE, PA., U. S. A.

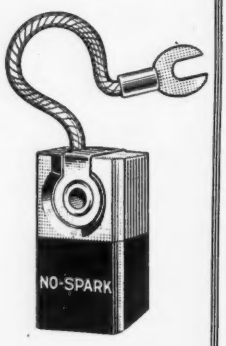
Insist on "No-Spark" Carbon Brushes

If you are hunting for a brush that will lengthen the life of your commutator, one that will stop sparking and one that will save you money in power and repairs be sure and insist on

NO-SPARK
Carbon Brushes

No ordinary brush will answer the purpose so well. The No-Spark Brush will outwear other brushes and for the same reason a commutator equipped with No-Sparks will give far better service than one equipped with an ordinary brush.

They will prove their worth best on your own commutators. Try them.



Calebaugh Self-Lubricating Carbon Co.
1503 Columbia Avenue
Philadelphia, Pa.

Measured Service

Do you **know** the resistance, hardness and transverse strength of the carbon brushes you are now using?

Do you **know** what they **should be** for the particular conditions each of your machines is working under?

Le Valley Carbon Brushes

are tested—not only for these important qualities, but for contact drop and co-efficient of friction. Thus the standards of quality are set for each different grade of Le Valley Carbon brushes—standards each suited to give the greatest service on a particular application.

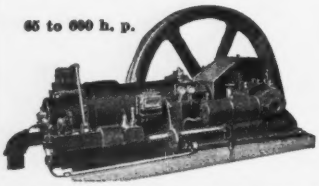
Then our superior manufacturing facilities and years of experience hold up our product to these standards. But to aid the user to get all this service reserve from Le Valley Carbon Brushes, we have prepared an invaluable data book, worked out at our expense by the Electrical Testing Laboratories of New York.

This defines the precise application of the particular type of brush needed in each service condition. Besides, you have at your service our own expert engineering department. So we say, "put your brush troubles up to us; we will furnish you measured brush service and see that you get the results."

No experimenting on your part—we do that for you. Write today for data book—sent on request.

Le Valley Vitae Carbon Brush Co.
22 West 23rd Street New York City

65 to 600 h. p.



Masterpieces of Economy

in fuel cost per hp. as well as in the elimination of annoyance of power failure, repairs and in the reduced attention in operation, is the testimony of users of

McEwen High Compression Oil Engines

Let us show you why we can save you money.

McEwen Bros. 4-20 South Main Street Wellsville, N.Y.

For Power or Heating

and for utilization of the greatest amount of energy contained in fuel,

Smith Suction Gas Producers

are demonstrating their **efficiency** and **economy** on over 80,000 h. p. in many of the best known power plants of the nation today.

They burn anthracite, bituminous, lignite, coke or charcoal, with great savings on fuel. Write for bulletins.

The Smith Gas Engineering Co.
Dayton, Ohio
Canadian Agents: Canadian Allis-Chalmers, Ltd., Toronto

"CARBONDALE" Refrigerating Machines

Using Exhaust Steam from Power Plant Equipment will Cool Your Refrigerators

Our System Is Efficient — Simple — Durable — Noiseless

ASK FOR INFORMATION AND CATALOGUE

A Few of Our Installations

N. Y. STOCK EXCHANGE MAYFAIR APARTMENTS ENGINEERS' CLUB
HOTEL BELMONT APTHORP APARTMENTS HOTEL ASTOR

The Carbondale Machine Company
Carbondale, Pa.
New York Chicago Pittsburgh Philadelphia Baltimore New Orleans

Established 1867

The Vilter Mfg. Company

972 Clinton Street, Milwaukee, Wis.

Builders of High Grade

CORLISS ENGINES

for Belted or Direct Connected Service

Ice Machines

Chicago Office, 731 Manadnock Block

Active sales representatives desired for unoccupied territory.

Insure Your Power House

with a

Castle Liberty No. 1

Insurance policies *do not* put out fires. They only pay for the damage done by the fire. The delay caused by having to rebuild or repair damage done by fire often costs more than the Insurance Company pays.

Avoid this delay by equipping your Power House with the *New Exclusive* CASTLE LIBERTY No. 1, a Three-Gallon Carbon Tetrachloride Type, Hand Pump Fire Extinguisher which has sufficient capacity to extinguish almost any fire apt to happen around the Power House.

Comparative and competitive tests have proved that a CASTLE LIBERTY No. 1 can extinguish fire that could not be controlled by twenty-eight one-quart fire extinguishers.

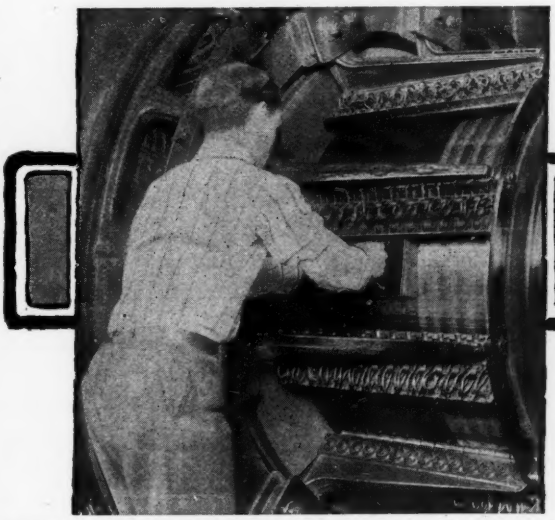
The extinguishing agent is Castle Liquid approved for Government use and used by leading Corporations, Railroads and Governmental Departments.

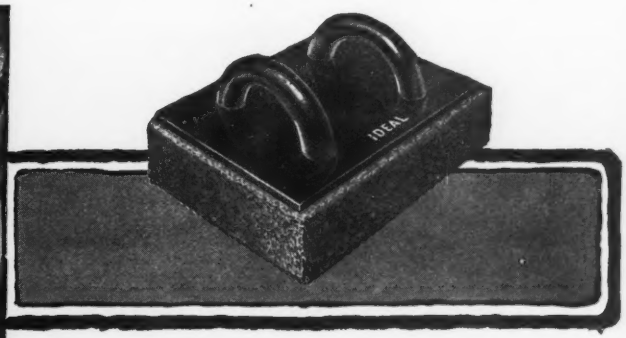
Write for complete description. Write for "Safety Always" telling the real story of fire extinguishing liquids. It tells you why so many one-quart extinguishers are out of service by reason of corrosion and it tells you how Castle Liquid corrects this trouble.

James M. Castle, Inc.

812 Lincoln Bldg., Philadelphia, Pa.

Manufacturers and Distributors of Fire-Extinguishing Apparatus.





Stop Power Loss—

due to sparking at the brushes of motors or generators. Don't remove your armatures and turn them down at the lathe—resurface them while in service, with an

IDEAL COMMUTATOR RESURFACER

—a manufactured abrasive block of uniform cutting quality. By simply holding it against commutators or rings, while machines are in motion, all ridges and high mica are cut down and sparking or loss of power eliminated. An occasional application keeps every machine in perfect condition.

The Ideal will not wear smooth, collect copper dust or cause short circuiting.

Many Sizes, Grades and Designs

They are made in various designs, sizes and cutting qualities to meet all conditions.

Try One Out FREE

Mail in the coupon for the free trial or an IDEAL. It will cost you nothing unless you decide after ten days' use to keep it. **Fill out the coupon and mail it in NOW.**

Ideal Commutator Dresser Co., P.P.E. 12-15-19
14 So. Dearborn St., Chicago.

Gentlemen: Please send me an Ideal Commutator Resurfaces for free trial. It is understood that if I am not fully satisfied with it I will return it at your expense. I want to use it on equipment as follows:

Approx. R.P.M.....Diameter of Commutator or ring.....

Approx. width of Commutator or ring surface.....

Approx. distance between brush sets.....Condition.....

Ring material (copper, steel, etc.).....

My name is.....Position.....

Company .....

Company address.....

City....., State.....

ECONOMY renewable FUSES

are the *right* fuses to protect *your* electrical circuits.

because they afford the right sort of protection; their reputation lends assurance that you can safely depend on them for accuracy of rating and all-around efficiency in operation.

because they cut annual fuse maintenance costs 80 per cent as compared with the use of one-time fuses, owing to the fact that an inexpensive "Drop Out" Renewal Link restores a blown Economy Fuse to its original efficiency.

because it's the work of a moment to replace the link and renew the fuse.

because a good sized stock of "Drop Out" Renewal Links always on hand represents but a small outlay.

Write for catalog 25

Economy Fuse & Mfg. Co.

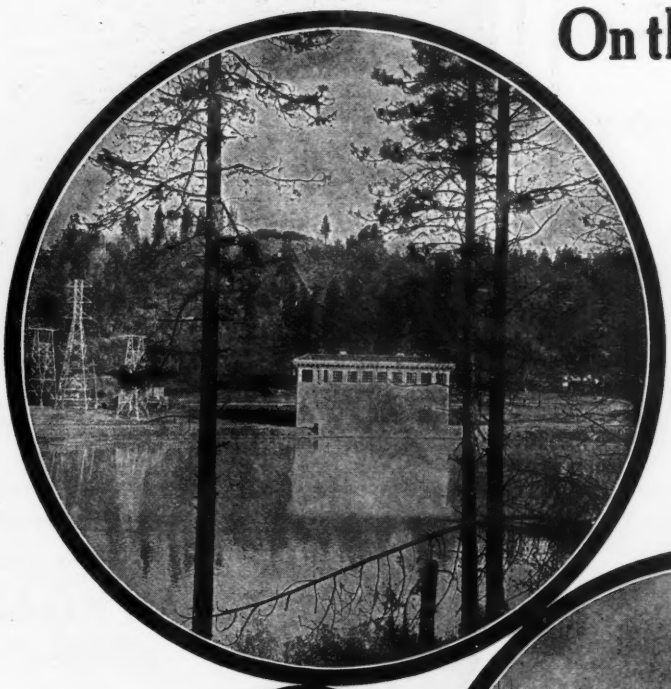
Kinzie and Orleans Streets CHICAGO, U. S. A.

Sole Manufacturers of "ARKLESS"—the Non-Renewable Fuse with the 100% Guaranteed Indicator

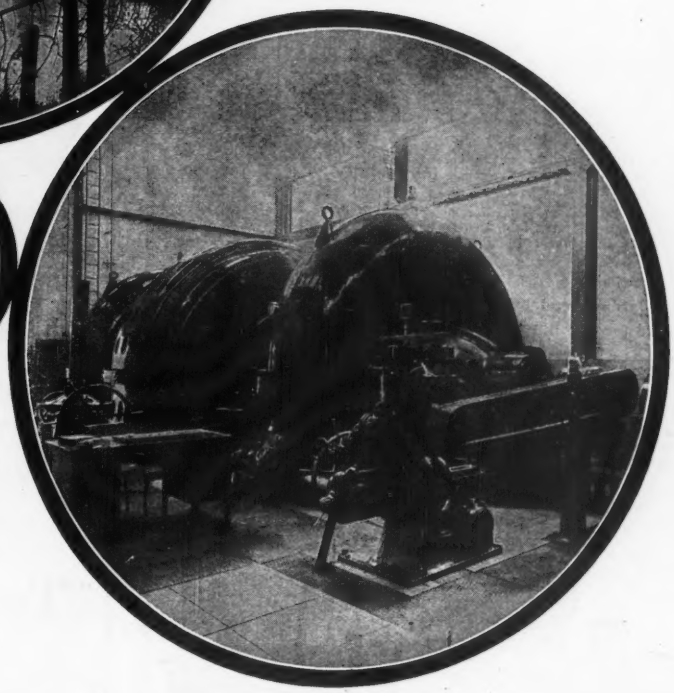
ECONOMY FUSES ARE ALSO MADE IN CANADA AT MONTREAL

Westinghouse

Water-Wheel Generators On the Pacific Coast



The Halsey Power Station of the Pacific Gas & Electric Co., is one of several which provide light and power through numerous sub-stations to the industrial and farming community in California, as well as to the electric traction systems.



W
WESTINGHOUSE ELECTRIC

The electrical equipment in this station consists of a Westinghouse 12,500 Kv-a, Horizontal Water-Wheel Generator.

The illustrations show an exterior and interior view of the Halsey Power Station.

Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

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Simple, Tandem, Cross Compound

ENGINES

are nationally eminent for their **dependability** and **efficiency.**

Our plant at Indianapolis covers 22 acres, and is fully equipped with the most modern electrically operated tools. Both our facilities and the records of our engines are convincing.

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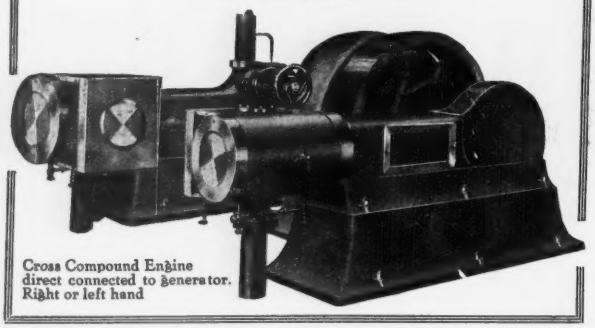


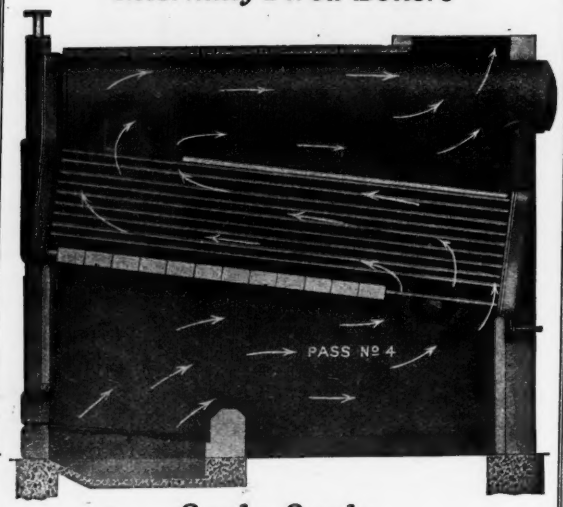
Cross Compound Engine direct connected to generator. Right or left hand

Freeman Manufacturing Co.

Racine, Wisconsin

Manufacturers of

Water Tube, Horizontal Tubular and Internally Fired Boilers



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Tanks, Steel Plate Work, Etc.

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Single or Multi-Stage

Built in sizes and capacities adapted to a wide range of use as auxiliary power units. Economical of steam. Low upkeep costs.

Casing horizontally split. Diaphragm horizontally divided and permanently attached to upper and lower halves of casing. Buckets of steel cold drawn or machined perfectly smooth, with ample clearance.

Capacities 5 to 1000 h.p. Speeds 1000 to 5000 r.p.m

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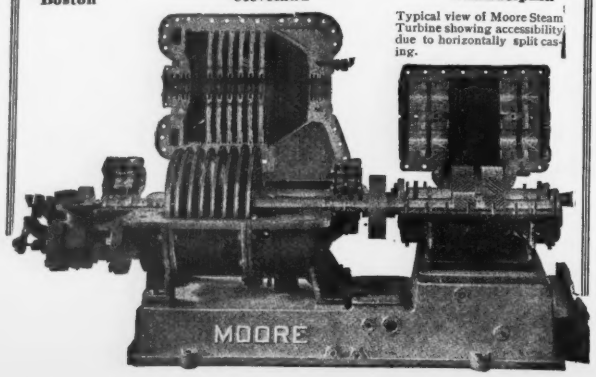

Typical view of Moore Steam Turbine showing accessibility due to horizontally split casing.

Ball Engines For All Kinds of Service

Reliable, Economical, Simple

Ball Engine Co.
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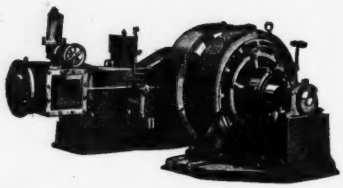

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Exceptional results in driving blowers, compressors, fans, generators, pumps, stokers and similar equipment, either belted or direct connected.

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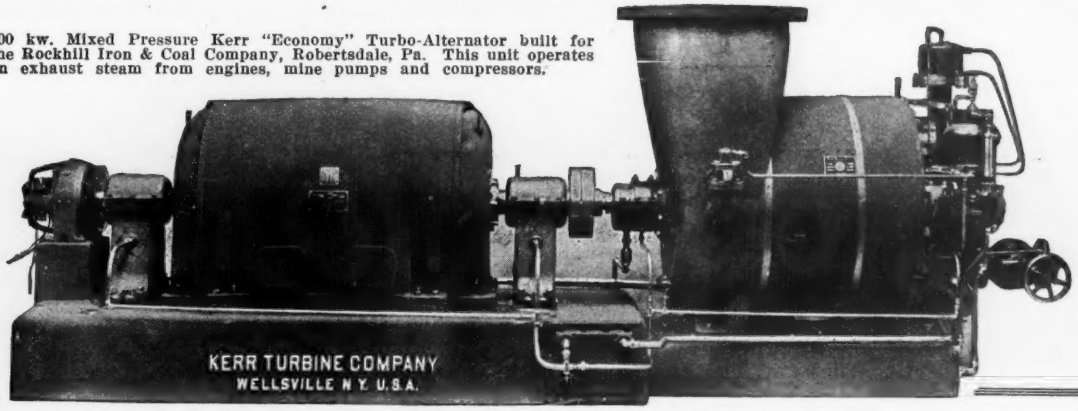

Power Almost as Free as Air

Power plants used to see exhaust steam going to waste without any remorse. It was one of those things that couldn't be helped. Today they install

Kerr "Economy" Exhaust Steam Turbines

and from this former waste derive fat profits. The by-product of engines, pumps, air compressors and other steam-driven machinery is made to generate electrical current. The initial expense is slight. The operating cost negligible.

There are few power plants in which from 50 to 100 per cent more power can not be obtained almost free of cost. This is a profit that counts up in the days of expensive coal.

If you are wasting these possible profits a Kerr "Economy" will show the saving way. Write for bulletins.

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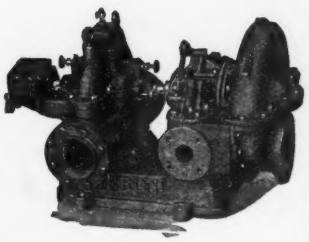
Two Bearing Units

Save
TROUBLE
WEIGHT
SPACE



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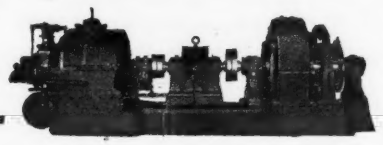

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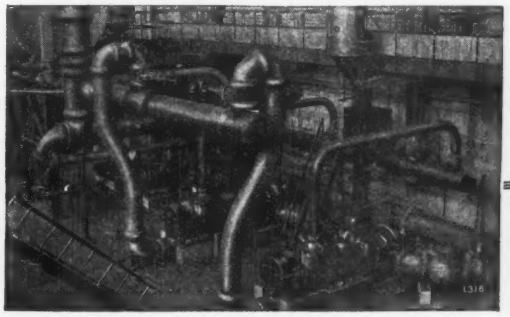

Modern Pumping Equipment

THE photograph shows two De Laval centrifugal pumps driven by De Laval geared steam turbines, in the power plant of a large iron and steel plant. Each pump handles 10,400 gal. per min. against a total head of 125 ft.

IN the background are two De Laval turbine-driven centrifugal boiler feed pumps, each having a capacity of 800 gal. per min. against a total head of 575 ft. These pumps receive their supply from the open feed water heater located directly above.

THERE are many reasons why the large steel mills, blast furnaces and other industrial plants, where economy and reliability are more imperative, use De Laval steam turbine-driven centrifugal pumps in preference to all others.

THESE reasons are explained in our special publications, which will be sent upon request, if you will state the nature of your requirements.

De Laval Steam Turbine Co.
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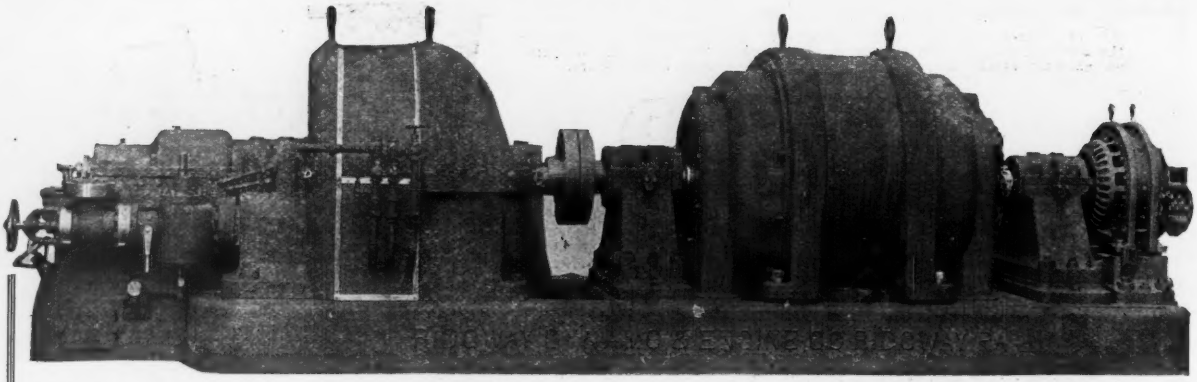
80



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Their extremely rugged construction enables them to meet all requirements of electrical service with perfect satisfection.

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Ridgway Dynamo & Engine Company, Ridgway, Pa.

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The Standard for Efficiency Durability Service
To save fuel, time, manpower and money, and speed up production in your plant, you can't find anything better qualified to co-operate with you than ENGBERG Direct Connected Generating Sets.
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ELECTRIC & MECHANICAL WORKS
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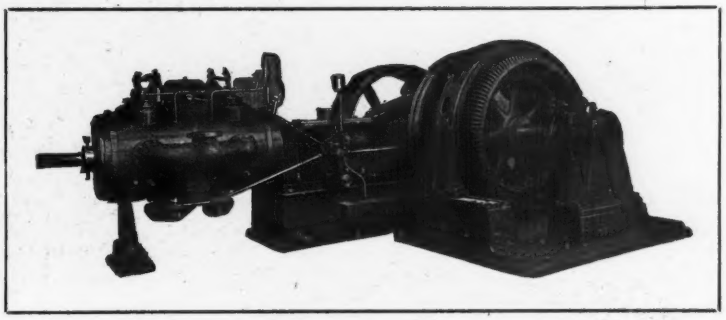
The Most Economical Steam Engine Ever Built



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is a competent, efficient and dependable, fully organized prime unit for the great work of reconstruction which lies before us at home and abroad. In the future, as in the past, its work will be found the height of power-producing perfection.

The "Universal Unaflow" gives Central Station Economy. Our literature gladly sent on request. Branches in all Principal Cities

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Embody the specialized skill of over 80 years of successful Engine building experience. Built in Simple, Tandem, and Cross Compound Corliss types in sizes ranging from 150 to 10,000 Horse Power.

The Cooper Improved Gravity-Latch Releasing Corliss Valve Gear is especially adapted to high rotative speeds and is simple and accessible and very noiseless in operation.

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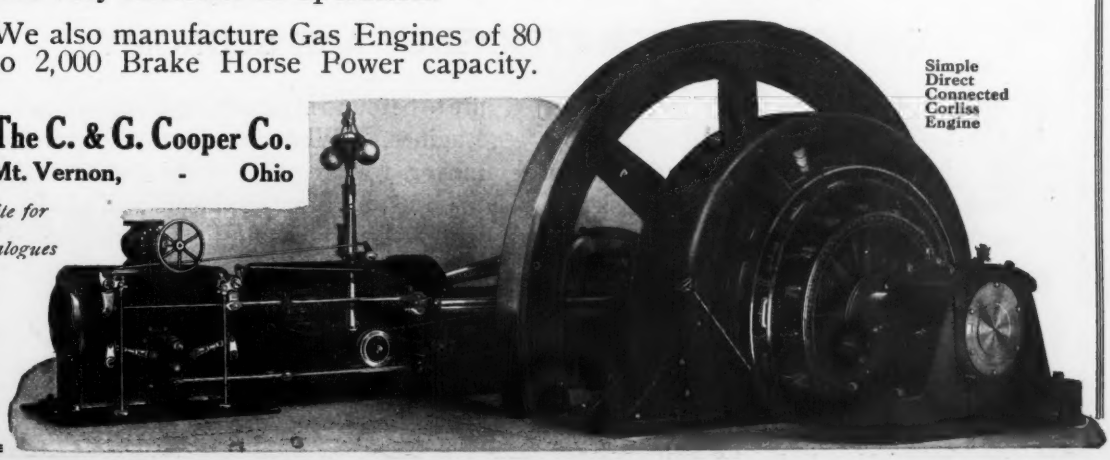
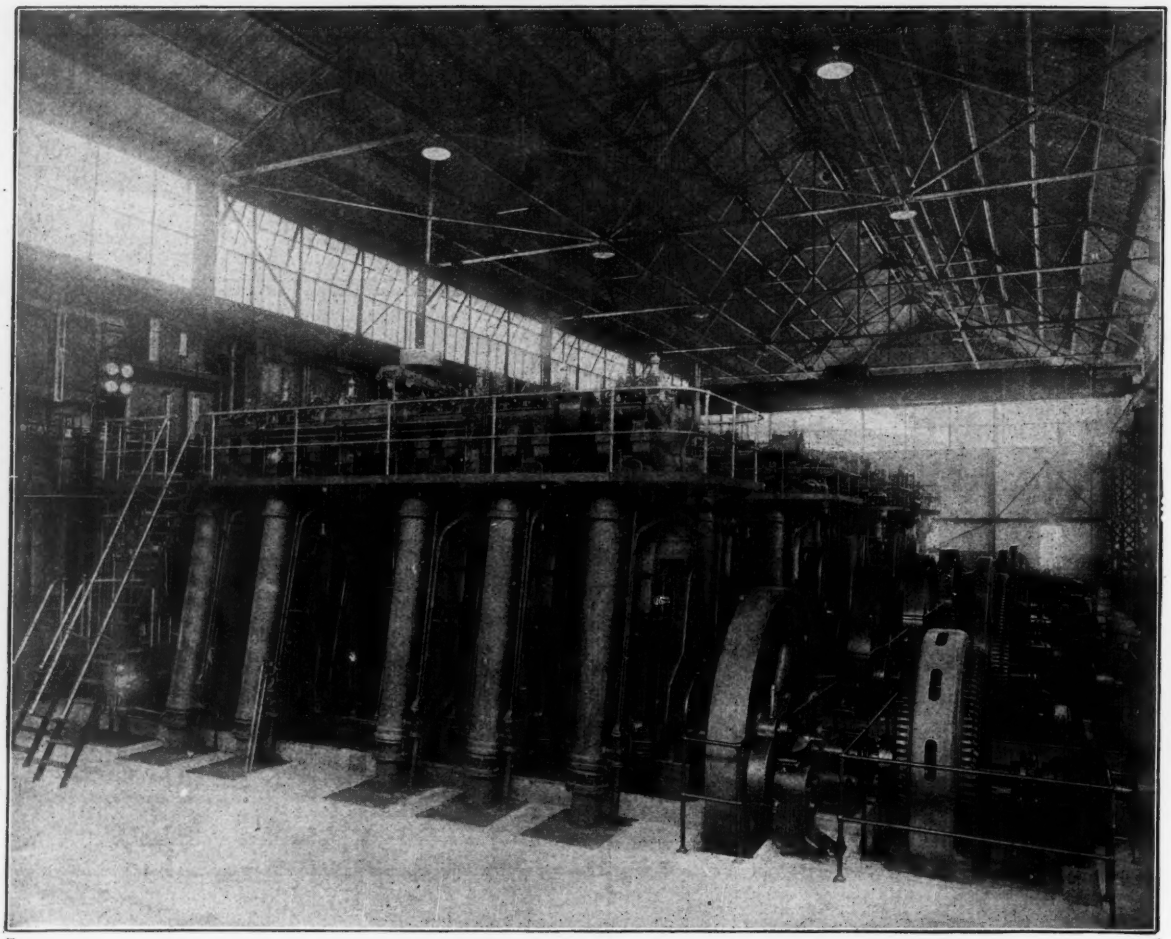


Simple Direct Connected Corliss Engine



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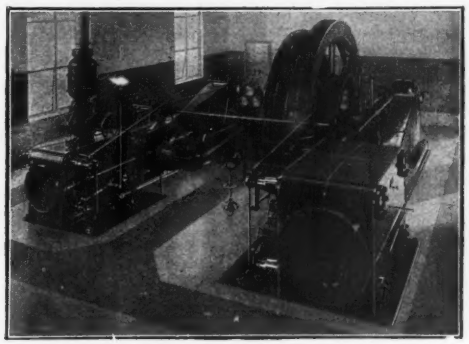

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